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THE 1938-39 EXPEDITION TO THE SNOW MOUNTAINS,
NETHERLANDS NEW GUINEA

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Concluded from page 295

1800 M. CAMP, 15 KM. SOUTHWEST OF BERNHARD CAMP

The 1600 m. crest of the steep-sided range that paralleled the valley of the Sahoenari River to the south and fronted the Meervlakte to the north was reached in two hours from the 1200 m. Camp. From there, seven hours of heavy travel along the top of the range, through mossy beech-forest that changed little in character but grew increasingly rich in species, brought one to the 1800 m. Camp. From this position views were had of the Idenburg, winding over its great plain 1750 m. below, and of range after range of high mountains piling up to the south and southeast.

Occupied by the collecting party from January 7 to February 1, this camp was, however, virtually in the clouds, and the few glimpses obtained of its surroundings were either very early in the morning, before the mist rose, or late in the afternoon, when the mist that had enveloped the ridge most of the day would sometimes disperse for the night. Light driving rain, becoming heavier as the day wore on, accompanied the mist, and severe rain squalls from the north, that uprooted trees left standing in the camp clearing, were all too frequent at night. Most of the mist was from clouds that rose rapidly from the Meervlakte with the first stirring of the light northerly wind which prevailed at that season. When the wind veered to the southeast a counter downward movement of mist was noted to take place in the afternoon. Warm fogs, which brought forth swarms of Lepidoptera

and other insects, sometimes rose from the Meervlakte at night. Temperature: maximum (20 days) 17–20.5, mean 18.5, minimum (21 days) 12–13.5, mean 13 degrees Centigrade.

Forests of *Nothofagus 11963*, about 25 m. in average height, occupied the summit of the range and followed the spur ridges down to at least 1550 m. on the southern slopes. But on the very steep northern face of the range, where there were no prominent spurs, and where the clouds, pushed up by air currents from the Meervlakte, maintained a higher level, they gave way to rain-forest not far below the summit. Other trees of the canopy layer included *Phyllocladus 11931* with fetid wood, **Calophyllum congestiflorum* A. C. Smith, which provided a good green firewood, and particularly *Weinmannia 11908*, which in parts could be called co-dominant. In *No. 11860* and *No. 12017*, the Cunoniaceae also figured prominently in the subsidiary tree layer, with **Metrosideros Pullei* Diels var. *parvifolia* White, *Quintinia 11856*, *Tetractomia Lauterbachiana* Merr. & Perry, and less commonly *Fagraea 12133*, Araliaceae 11855 (also epiphytic) and ***Archboldiodendron calosericeum* Kobuski, the latter a striking tree with silver-pubescent leaves. Massed on the lower tree-trunks were climbing *Cyathea biformis* (Ros.) Copel., *Freycinetia laterifolia* Ridl., **F. erythrospatha* Merr. & Perry and *Pothos 12100*, while *Tecomanthe 12002*, with very large pink flowers, occurred as a canopy liane. Characteristic of the thin undergrowth developed under dense shade were the little tree-ferns *Cyathea perpelvigera* v. A. v. R. and *C. melanoclada* Domin, slender Araliaceae, *Medinilla 11878* embedded in moss, and such small herbs and ferns as *Argostemma 11892*, *Burmannia 11889*, *Lindsaya marginata* Brause, *Grammitis knutsfordiana* (Baker) Copel., and saprophytic *Corsia 12120*. The chief wealth of these forests was, however, in their epiphytic flora, which included most of the shrubs and ferns and practically all of the numerous orchids. Most important in a list of over thirty woody epiphytes were Araliaceae (4 spp.) and Melastomataceae (2 spp.), growing near the ground, and *Vaccinium 12105*, *Rhododendron 11876*, *R. 12001*, *Drimys 12006*, *Rapanea 12360*, *Sericolea 12418*, Myrtaceae 12057, *Hydnophytum 12111*, and scandent *Lucinaea 11858*, *Psychotria 12299*, *Alyxia 12303* and *Nepenthes 11900* at middle and upper levels. The few flowering herbs other than orchids included several Zingiberaceae. Notable among a host of ferns were *Plagiogyria tuberculata* Copel., *Oleandra Wernerii* Ros., **O. crassipes* Copel., *Polypodium plebiscopum* Baker, *Calymmodon mnioides* Copel., *C. atrichus* Copel., *Dryopteris Lauterbachii* Brause, *Sphaerocionium pilosissimum* (C. Chr.) Copel., and *Macroglena meifolia* (Bory) Copel. at low to

middle levels; *Humata kinabaluensis* Copel., *Grammitis interrupta* (Baker) Copel., *Polypodium plebiscopum* Baker, **Amphipterum humatoides* Copel. and *Pleuromanthes pallidum* (Bl.) Copel. occurred in the tree-tops.

Small openings made by landslips and windthrows, and the rest and camp clearings of the natives who occasionally visited the range from the Sahoenari Valley, carried secondary communities very different in the main from those of disturbed areas in rain-forest. Appearing early, with clumped *Riedelia* 11893 and *Dianella* 12003, were small shrubs such as **Eurya gracilipes* Kobuski and *Medinilla* spp., scrambling *Palmeria Fengeriana* Perk., *Nepenthes* 11900, *Lycopodium cernuum* L. var., **Sticherus venosus* Copel. and **Hicriopteris astrotricha* Copel. Later the small-leaved slender trees *Rapanea* 12106 (also in forest undergrowth), *Drimys* 11857, *D.* 12149, and to some extent *Rhodomyrtus novoguineensis* Diels and *Melastoma* 12154 formed dense stands 3-4 m. high. Forest stands of chiefly *Eurya Groffii* Merr. (?) and *Quintinia* 12061, 10-12 m. high, developed before the return of the climax species to dominance. Several probable intruders from rain-forest, e.g. *Homalanthus* 12058, *Breynia* 12300 and **Pandanus actinobotrys* Merr. & Perry, occurred in the larger openings.

Even on the cloud-shaded south slope of the range, rain-forest ascended the ravines to within 50 m. of the summit. At about 1500 m. on these slopes *Lithocarpus* 11971, *L.* 11981, *Castanopsis* 11969 and *Engelhardtia* 11916, the latter an associate of the oaks in most localities, appeared as common trees. Included in 40 to 50 species of rain-forest canopy trees collected at altitudes down to 1500 m. were about fifteen of *Syzygium* and five Lauraceae. Most common were *Syzygium* 11935, *S.* 11978, *Garcinia Schraderi* Lauterb., *Cryptocarya* 11911, *Ficus* 11921, *Astronia* 11937, *Elaeocarpus* 11939, *Laurac.* 11968, **Vavaea Archboldiana* Merr. & Perry and **Acronychia goniocarpa* Merr. & Perry. Characterizing the very luxuriant undergrowth developed in the bottoms of ravines were *Saurauia* spp. (3), *Cyrtandra* spp. (6), *Elatostema* 12029, *Ophiorrhiza* 12251, *Begonia* spp. (4), Zingiberaceae (6), and a complement of ferns unequalled for variety or abundance in any other habitat or locality on this range or on the Snow Mountains, e.g. *Cyathea* spp. (5) including **C. horridula* Copel. and *C. Rosenstockii* Brause, **Marattia coronata* Copel., *Leptopteris alpina* (Baker) C. Chr. var. *major* Ros., *Athyrium acrocarpum* (Ros.) Copel., **A. latilobum* Copel., *Vandenboschia maxima* (Bl.) Copel., *Dryopteris canescens* (Bl.) C. Chr. var. *novoguineensis* Brause, **D. vestigiata* Copel. and *Orthopteris minor* (Hook.) Copel. Essentially of ferns, the abundant low epiphytic

flora included *Mecodium Reinwardtii* (v.d.B.) Copel., **Pleuromanes retusum* Copel., *Goniophlebium demersum* (Brause) Copel., *Lindsaya marginata* Brause, *Asplenium cromwellianum* Ros. and *A. ellipticum* (Fée) Copel. Although poorer in species, the tree-top flora agreed with that of the adjacent beech-forests.

Of approximately 100 species of ferns, including 17 Hymenophyllaceae, collected in this camp locality, considerably more than half were found between the 1750 m. and 1600 m. levels in one rain-forest ravine. The beech-forests were rich in Ericaceae (about 8 species) and Melastomataceae (about 7 species). Two of four species of palms, *Calamus 12174* and *Ptychandra? 12119*, entered the beech-forests. *Freycinetia* was represented by four prominent species (3 in beech-forest), and *Pandanus* by four species of which three entered at least the edges of the beech-forest.

2150 M. CAMP, 18 KM. SOUTHWEST OF BERNHARD CAMP

This camp, where botanical collections were made from February 1 to 10, stood on the scrubby point of a very narrow wind-swept bluff 100 m. high, that broke the crest of the range two hours' journey beyond the 1800 m. Camp. In another kilometre the range rose to 2250 m. in a small peak, then dropped away as it continued westward toward Mt. Angemoek. A magnificent panorama from the point of the bluff took in a sweep of about 230 degrees, embracing Mt. Wilhelm, the Cyclops Mts., and almost the entire valley of the Idenburg from the western end of the Gauttier Mts. to near the border of North-eastern New Guinea. Below, in the secluded V-shaped valley of the Sahoenari, on slopes largely deforested and grass-grown from about 1400 m. down to the river at approximately 1000 m. elevation, were the villages and gardens of a rather numerous population.

General weather and cloud conditions were similar to those experienced at the 1800 m. Camp. But on the exposed point of the bluff the wind attained a greater velocity at night, and, until late in the morning, up draughts and cross currents often maintained a sunlit opening when below and on all sides were swirling clouds of mist. Standard shade temperature rose as high as 26.5° in camp, while in the forest, less than 100 m. away, warm clothing was necessary for comfort at any time of day. Temperature: maximum (7 days) 20.5–26.5, mean 23, minimum (7 days) 11.5–12.5, mean 12 degrees Centigrade.

Rain-forests like those of the previous camp locality, but with a diminished undergrowth and fern flora, occupied the ravines up to an alti-

tude of 2000 m. more or less. Prominent in the rain-forest and in transition beech-forest was the very tall **Pandanus brosimos* Merr. & Perry, resembling the species planted for its seeds by the natives of the Snow Mountains, and here in some cases bearing marks of native ownership.

More massive at this altitude, and averaging 15–20 m. in height except in the immediate vicinity of the bluff, the beech-forests were composed of *Nothofagus* 12453 and *N.* 12675, with *Weinmannia* 11908, *Phyllocladus* 11931, and the hitherto unencountered conifer *Dacrydium* 12659 associated as common though relatively unimportant canopy trees. Prominent as subsidiary trees, and largely replacing the species of the previous camp locality, were *Xanthomyrtus* 12452 and *X.* 12631. A scrambling bamboo (*No.* 12662), present in small quantities down to 1600 m. on the crest of the range, filled the forest and practically excluded other undergrowth above the 2200 m. level:

On the crest and sides of the exposed point of the bluff the forest degenerated into a very dense heavily mossed scrub of tough trees and shrubs 2–3 m. high, comprised of *Nothofagus* 12453, here flowering as a shrub, and the two *Xanthomyrtus* spp. and *Mearnsia cordata* White & Francis from the adjoining tall forest, and also containing an abundance of such second growth elements as *Rapanea* 12450, *Drimys* 12629, *Quintinia* 12194, *Kania* 12628, *Sericolea* 12637 and **Ternstroemia sphondylophora* Kobuski.

Old rockslides on the face of the bluff carried, in association with *Sphagnum sericeum* C. M., a cover of *Sticherus hirtus* (Bl.) Copel., *Gleichenia peltophora* Copel., *G. circinnata* Sw., *Hicriopteris arachnoides* (Hassk.) Copel., *Dipteris conjugata* Reinw. and *Lycopodium* 12460, in which grew the whipstick *Rhododendron* 12445 and other small trees and shrubs. Lichens and the mosses *Campylopus umbellatus* (W. Arn.) Bartr. and *Dawsonia limbata* Dix. preceded the ferns on newly disturbed areas, and the scrub community followed the ferns.

With the exception of the ferns, of which only *Dipteris conjugata* was found elsewhere, most of the plants mentioned as characteristic of the open habitats and low vegetation of the bluff were found in beech-forest in other localities and may be considered as belonging to this type of forest. Plentiful also, and of interest as an example of aberrant altitudinal distribution, was subalpine *Libocedrus* 12190, growing to a height of 15 m. on the edges of old rockslides and in the forest on very steep rocky slopes. *Rhododendron* 12442, of the scrubs, appeared identical with a species abundant at Lake Habbema and on the slopes of Mt. Wilhelmina, and some associated *Vaccinium* spp. will probably prove to be subalpine.

BALIM RIVER, 1600 M. CAMP

The collecting party worked here from December 7 to 20. This was at the turn of the seasons. Afternoon thunderstorms brought frequent rains, and many gardens were being dug in preparation for the main sweet-potato planting of the year. While doubtless bringing sufficient rain to sustain the growth of crops, the southeast tradewinds nevertheless had a pronounced drying effect in this deforested valley. Almost daily in late December the trades still blew up the valley with force after 9 a.m., and it was noted that most of the native villages occupied positions in depressions or behind sheltering groves of *Casuarinas*. Fogs, which had been observed from the mountains to form a low cloudbank in the valley, often lay over the bottom lands very early in the morning, and, breaking up over the valley and rising on the slopes as the day warmed and the wind rose, re-formed on the mountainsides, about the upper level of cultivation, in the middle of the forenoon. Temperature: maximum (8 days) 21–29.5, mean 25.7, minimum (8 days) 13.5–15.5, mean 14.7 degrees Centigrade.

Relics of the forests which, prior to the advent of man with his stone tools and fire, undoubtedly occupied the whole of the valley apart from marshes and occasional rock-faces, survive on an incalculably small area at the present time. No more than 1 per cent. of the parts now inhabited are actually under crop. An estimated 20 per cent. is wooded with secondary forest, while the remainder consists of open grasslands and, in parts of the valley, considerable tracts of open marsh.

In no part of the Grand Valley was destruction of the forests more complete than in this camp locality near its lower end. However, from the few relics of the former vegetation which existed in this particular part, and the more numerous and extensive areas of primary forest of the type encountered between here and the Bele River, it would seem that very extensive forests of oaks and *Castanopsis* once clothed the ridgy terrain of the valley bottom and extended up the slopes to elevations of approximately 2000–2200 m. The upper limit of deforestation and cultivation lay in beech-forest at about 2400 m. Not a single patch of primary rain-forest survived in any part of the valley traversed by the expedition. But from the presence of scattered trees such as *Cedrela Toona* Roxb. var. *australis* F. v. M. and *Ficus* spp., the important part played in secondary communities by rain-forest species, and furthermore, the strong representation of rain-forest elements at much higher elevations in the branch valley of the Bele River, it would seem safe to conclude that forests of this type formerly covered the rich

alluvial plains that occupy a large part of the valley bottom and reached far up the slopes in ravines and the valleys of tributary streams. The trees of the primary rain-forest that have survived possibly did so by virtue of their ability to reproduce themselves in more or less open situations on the banks of streams, in waste corners, and even on stone piles in the gardens.

In the light of recent explorations in the three political territories, it can be said that, in the mountains of New Guinea, man follows the oaks. For it is in the cool, healthy, now grassy mid-mountain valleys, where the oak-*Castanopsis* forest attains a massive development, that the teeming tribes of the far interior, the greatest concentrations of population on the entire island, have been discovered during the last decade.

Isolated small clumps of *Castanopsis* 11702, which contained also *Lithocarpus* 11177 and *L.* 11180 at elevations above 1750 m., occurred here and there on the grasslands which occupied all but a small part of the valley in the neighbourhood of the Balim Camp. **Celtis similis* Merr. & Perry and *Podocarpus* 11187 grew in one patch, and a striking group of *Araucaria* 11175, sparsely foliated and infested with lichens, stood across the river from camp. Most important of the forest remnants in respect of area was a "gallery" strip on the banks of a foothill stream. This consisted of a pure stand of *Castanopsis* 10 m. high, thick-boled and with spreading branches, under which, as in more extensive forests of the kind passed through on the journey down from the Bele, **Humata mecodioides* Copel. formed a dense patched ground cover. An exceptional wealth of other semi-xerophytic ferns included *Polypodium plebiscopum* Baker, gregarious on the ground, *Nephrolepis cordifolia* (L.) Presl and *Davallia trichomanoides* Bl., on both trees and ground, and the epiphytes *Vittaria zosterifolia* Willd., *Grammatopteridium costulatum* (Cesati) C. Chr., **Davallia tenuisecta* Copel. and *Drynaria rigidula* (Sw.) Bedd. A sparse undergrowth of slender treelets included **Eurya pluriflora* Kobuski and *Pittosporum rami-florum* Zoll.

Owing perhaps to climatic influences or the constitutional limitations of the second growth species, or both, forest regeneration at this altitude and the resistance offered to invading grasses are much less vigorous than on the more tropical lower slopes of the mountains and on the humid lowland plains. This is especially true of the oak-*Castanopsis* forest. It is on the well drained soils formerly covered by forest of this type that the effects of human disturbance in modifying movements of progress and regress in the impact of the grasses with the

secondary forest communities is most pronounced, and the hold of the grasses in consequence most secure. Most of the secondary forest of the Balim Camp area occurs on the relatively small areas of moist alluvial soil, places reserved by selection as desirable for its preservation for shelter and timber supply, patches of very stony or sandy soil no longer suitable for cultivation, and areas remote from present day habitations.

Slowly, when relieved from disturbance by shifts or local decreases in population, the woody second growths gain ground and set up conditions which would in time permit the return of the original forest trees. This process is rather well advanced in parts of the valley in which, if one may judge from the ruins of stone walls and the pattern of garden beds still evident on the ground, population was as heavy as it is in the Balim Camp area today. Firing of the grass in hunting drives and to attract game to fresh feed on burnt areas, a potent factor in maintaining man-made grasslands in some regions, perhaps seldom takes place even in heavily populated parts of this valley. It appears that hunting is not a regular occupation of the people. They have few dogs to assist in the chase, and in the absence of grassland wallabies (*Macropus*) and bandicoots (*Isodon* and *Peroryctes*) there is nothing to hunt except an occasional escaped pig. Most grassfires might therefore be attributed to the propensity of the New Guinea man to burn for the sake of burning, an inclination which, through considerations of personal safety or respect for the property rights of neighbours, is perhaps seldom indulged in beyond the territorial boundaries of the community. Lands weakly held by scattered peoples will, in consequence of this combination of circumstances, for a time stay more or less undisturbed and begin to revert to forest. But almost certainly, while population in the valley maintains its present level, these vacant lands, enriched by young forest or by the rank grass growth of years, will be reoccupied, and the valley of the Balim will remain largely a valley of grass.

When a grassland garden is abandoned after one or more seasons, it returns to grass. In the Balim Camp area the principal species that institute the reversion are *Digitaria pruriens* (Fisch.) Buse and *Setaria geniculata* (Lam.) Beauv., followed by *Ischaemum pubescens* Merr., on soils of the slopes. On moist flats *Ischaemum digitatum* Brongn. early takes possession, and the older growths consist of rank stands of this species, *Apluda mutica* L., and 2 m. high thickets of *Phragmites Karka* (Retz.) Trin., *Saccharum spontaneum* L. and *Miscanthus japonicus* (Houtt.) Anders., with which are associated *Cudrania 11807*, forming large clumps or scrambling on Casuarinas, *Rhamnus javanicus* Miq.,

Desmodium 11799 and *Rubus rosaeifolius* Sm. Tall stands of *Pennisetum macrostachyum* (Brongn.) Trin. often occupy very stony ground. *Imperata cylindrica* (L.) Beauv. is plentiful on new and old grassland on all types of soil.

About 60–80 cm. high, the dominant grasses of the old-established grasslands of the slopes are *Germainia capitata* Bal. & Poitr., *Ischaemum pubescens* Merr., *Imperata cylindrica* (L.) Beauv., *Andropogon intermedius* R. Br., *Sorghum nitidum* (Vahl) Pers., *Apluda mutica* L. and *Pollinia leptostachys* Pilg. Smaller mostly annual grasses include *Andropogon brevifolius* Sw., *Eragrostis distans* Hack., *Dimeria falcata* Hack., *Aristida Cumingiana* Trin., *Sacciolepis contracta* (Wight & Arn.) Hitchc. and *Isachne globosa* (Thunb.) Ktze. Among common herbs and small woody associates are *Euphorbia serrulata* Reinw., *Spilanthes* 11626, *Wahlenbergia gracilis* A. DC., *Hedyotis* 11628, *Halorrhagis* 11629, *Crepis japonica* Benth., *Cassia mimosoides* L., *Xyris* 11721, *Borreria* 11737, *Uraria lagopodioides* (L.) Desv. and *Osbeckia chinensis* L. Common shrubs are yellow *Rhododendron* 11694, originally of forest openings, and *Melastoma* 11712.

Only distant views were had of the large marshes of the valley. Representatives of this flora, inhabiting drainage ditches, pools and wet fallow land, included *Leersia hexandra* Sw., *Polygonum* spp. (3), *Hygrophila* 11673, *Hydrocotyle* 11790, *Alternanthera sessilis* (L.) R. Br., *Carex* 11791, *Scirpus* 11804, *Jussiaea* 11792, *Smithia* 11651, *Echinochloa crusgalli* (L.) Beauv. and *Limnanthemum indicum* Thw.

Under primitive conditions *Phragmites*, *Saccharum*, *Miscanthus*, *Pennisetum* and *Imperata*, wind-dispersed grasses of wide distribution in New Guinea, doubtless occupied limited open habitats provided by riverbanks, streambeds, landslips and edges of marshes, and the clearing of the forests has allowed them to extend their area. But most of the species involved in stocking the old-established grasslands are essentially plants of extensive open habitats and dry soils, whose seeds are not adapted for dissemination by wind, and whose nearest known primary habitat is the lowland savanna and savanna-forest between the Fly and Digoel Rivers, 300 to 350 km. to the east and southeast. Bridging this considerable gap, at least man-made habitats suitable for such plants may be expected to occur at intervals, if not on the sparsely peopled lowlands, almost certainly in inhabited valleys on both sides of the central range; but so far as is known to the writer, the farthest inland savanna on the Fly is 200 km. from any grassy mountain valley. Plants of the savanna grasslands apparently occupy, from end to end of the island, isolated mountain stations such as the Balim Valley,

besides many lower altitude stations such as Lake Sentani. But with the exception of the *Eucalyptus-Melaleuca* savannas of the semi-arid Fly-Digoel area and the area between Cape Possession and the Kemp Welch River on the south side of the island, and perhaps an area about Cape Vogel and another on the Rai Coast on the north side of the island, all the known New Guinea grasslands at low to moderate elevations are a secondary condition due to the activities of man.

Six true grassland birds were found in the Balim Valley by Rand, who furnishes the following significant data on their known distribution. Two, *Lonchura teerinki* and *Malurus alboscapulatus balim*, proved new species and subspecies endemic in the valley. The latter has its closest relatives in south New Guinea, and a very different race occurs at Lake Sentani. Of the remaining four, one, a quail, occurs in south and east New Guinea, but has not been found in any northern locality west of the Watut River; two belong to south and southeastern races of species represented by different races on the north side of the island; the other is a widespread bird whose exact status has not been determined.

Zoological and botanical exploration in New Guinea is not, however, sufficiently advanced for much importance to be attached to instances of apparent local endemism. But for small collections from the Mt. Hagen area and the Markham River headwaters in Northeast New Guinea, scarcely anything is known of the fauna and flora of the numerous deforested valleys of the central mountains for the stretch of 900 km. between the sections examined by the Archbold expeditions of 1933-34 and 1938-39. The new birds of the Balim discovered by the last-named expedition may be no more endemic in that valley than the extra-limital grasses *Andropogon intermedius* R. Br. and *Aristida Cumingiana* Trin., whose only recorded station for the island is the Balim Valley. Yet apart from the occurrence of birds whose endemism, if granted, can not be held to argue the existence of their habitat before the advent of agricultural man, no evidence is available upon which an estimate as to the age of grasslands such as those of the Balim might be based, unless the controversial question of the introduction of the sweet-potato is taken into account.

In the Balim Valley, as in the valleys of the Purari Plateau in Northeast New Guinea, where great native populations live at elevations of approximately 1500-2000 m., the sweet-potato, now accepted as of Central or South American origin, is the basic crop. Taro, the staple in some of the less elevated New Guinea valleys, is grown as a very minor subsidiary crop, as are bananas, sugarcane and cucumbers. Yams, which were not seen in the Balim Valley, appear not to succeed at

altitudes above about 1500 m. Frederici¹ explains the important position attained by the sweet-potato as a food crop on the islands of New Zealand, Rapanui and Hawaii as due to climate, which is particularly suited to the sweet-potato on those islands, but not so favourable to the tropical crops that provide the basic food in other parts of Polynesia. The importance of the sweet-potato in the high valleys of New Guinea might also be explained by climate. Whether an original crop brought in by the settlers of the valleys with food plants of old world origin such as taro, bananas, sugarcane and perhaps yams, or a replacement crop that appeared later, its present pre-eminence, based on its advantages in point of yield, is such that it is doubtful if the populations could have reached their present development on any other available food source. Grounds therefore exist for the view that most of the activity in converting the high valleys to grass post-dated the arrival of the sweet-potato. If, as held by Dixon² and others, this crop was introduced into Polynesia through pre-Caucasian contacts with the American continent, it might conceivably have reached New Guinea, by way of Melanesia, at a very early date. If Frederici is correct in considering it a Spanish introduction in Polynesia, and in attributing to the Spanish and Portuguese its introduction everywhere west of the Solomon Islands, the sweet-potato is unlikely to have appeared on the New Guinea coast before the middle of the sixteenth century.

Pure secondary forests of *Casuarina* 11172, 25–30 m. high, conserved in blocks and strips on riverbanks and the lower slopes, were a striking feature of the landscape in the vicinity of the Balim Camp. This wind-dispersed tree and *Ficus* 11167, a low tree also abundant on river flats, formed, on the debris of the great erosion cut mentioned on page 280, the largest stand of second growth forest in the locality. The generally sandy soils of old grass slopes carried in places sparse brushes of **Vaccinium adenantum* Sleumer, *Alphitonia ferruginea* Merr. & Perry, *Grevillea subargentea* C. T. White, *Timonius* 11748, *Decaspermum* 11643, *Glochidion* 11642 and *Piper* 11670, 3–5 m. high. In sclerophyllous scrubs on limestone knolls and declivities, *Grevillea*, *Rhamnus javanicus* Miq., *Leucosyke* 11632, **Eurya Dielsiana* Kobuski and *Schefflera* 11713 figured as low trees and shrubs. **Ilex Versteeghii* Merr. & Perry, *Maesa?* 11769 and especially *Xanthomyrtus* 11784 formed low shrubberies on stony slopes above 1700 m.

A distinctive scrub community, dominated by **Vaccinium adenantum* Sleumer, occupied a patch of poor loose sand at an elevation of

¹FREDERICI, G. Ges. Volkerk. 7: 2–7. 1936.

²DIXON, R. B. Amer. Anthropologist 34: 40–66. 1932.

2100 m. Only 3–4 m. high, this resembled the scrubs of the 2150 m. Camp in the abundance of *Mearnsia cordata* White & Francis and *Kania* 11764, and of the ericoid subalpine shrub *Rhododendron* 11751 fringing the edges. Conspicuous about the borders, and in glades of bracken (*Pteridium lanigerum* (Bl.) Copel.), were *Rhododendron* 11758, with fragrant white flowers, and large clumps of *Gahnia* 11765. Similar secondary scrubs occurred at an elevation of 2200 m. at the mouth of the Bele Valley.

BELE RIVER (2200 M.) CAMP, 18 KM. NORTHEAST OF LAKE HABBEMA

This camp was occupied by the collecting party from November 9 to December 5. It stood on a grass patch on the high right-hand bank of the river, here a rapid mountain stream with a rocky and bouldery bed 20 m. wide. Just below camp the river entered a limestone gorge. Upstream were several narrow stretches of alluvial bank edged with gravel, and at a distance of half a kilometre, a shorter gorge. Clear mornings, crisp in the early hours, and rainy afternoons characterized local weather conditions. Four days were without rain, 5 overcast throughout, and 16 rainy in the afternoon—the heavier rains often accompanied by thunder and continuing to 8 or 9 p.m. There was little air movement in this narrow valley, which lay directly across the path of the tradewinds and was protected on either side by high mountain spurs. Cloud formation on the slopes lacked the regularity exhibited in localities exposed to steady air currents, and although clouds drifted in from the Balim Valley, the general movement was downward from the higher mountains. Generally, however, mist clouds clung to the slopes after about 10 a.m., their lower limit in fairly close correlation with the upper limit of cultivation at approximately 2400 m. Temperature: maximum (22 days) 19–26, mean 23, minimum (22 days) 9–12.5, mean 10.5 degrees Centigrade. Relative humidity (isolated readings): at 6 a.m. 88%–95%, mean for 8 days 91%, at noon 43%–66%, mean for 5 days 55%.

From the bottom of this valley, or the upper edge of the native gardens, magnificent forests of *Nothofagus* extended up the slopes of the range to an altitude of 3100 m. near Lake Habbema. In the Bele Valley these forests consisted of three species of towering clear-boled trees that attained a height of 40 m. or more and a diameter of well over 1 m. Distinguishable at a distance by the pale reddish colour of its young leaves, *N.* 11369 supplied most of the stocking below 2400 m., *N.* 11115, with young leaves of a deeper red, rougher bark and larger

fruit, dominated the forest above that level, and *N. 11335*, yellowish in young leaf, was plentiful at about 2300 m. Lauraceae supplied 6, *Elaeocarpus* 7, *Syzygium* 8, Cunoniaceae 8, *Podocarpus* 2 (the only conifers) and Fagaceae 4 of a total of about 60 collected species of associated trees that attained a diameter of 25 cm. or more between elevations of 2200 to 2500 m.

The *Nothofagus*-forests of these altitudes on the slopes of the Snow Mountains differed vastly in character from those of the mountains southwest of Bernhard Camp. The term "mossy-forest," which has been used to describe several types of stunted mountain forest in Malaysia, could not be applied here. Above, and even below, the rather arbitrary level of 2400 m. set for the line of demarcation between the two *Nothofagus* consociations, there was, however, especially on the crests of spur ridges, a considerable development of mossy ground cover; hepatics and mosses formed soft mounds about the bases of the great trees, and the soil became generally too peaty for cultivation. The top-most gardens were in hollows between spurs, where mossed conditions were less pronounced, and rain-forest elements conspicuous in the forest. Further description of the *Nothofagus*-forests is deferred for the 2800 m. Camp, where they exhibited the same broad characteristics.

Many of the commoner rain-forest elements which, particularly as regards undergrowth species, lent a tropical aspect to parts of the forest on riverbanks and in moist hollows and extended in diminishing numbers far up the slopes in this locality, reached still higher altitudes in valley bottoms. The following characteristic rain-forest families, all but one represented by single species, appeared to reach the upper limit of their range in primary *Nothofagus*-forest between 2200 and 2500 m: Sapotaceae (*No. 11139*), Staphyleaceae (*Turpinia 11143*), Icacinaceae (*Platea 11119*), Meliaceae (**Aglaia Versteeghii* Merr. & Perry), Chloranthaceae (*Chloranthus 11479*), Celastraceae (**Perrottetia traumato-phylla* Merr. & Perry), Oleaceae (**Linociera Brassii* Kobuski, *Jasminum domatiigerum* Lingelsh.), Begoniaceae (*Begonia 11228*). *Aristotelia 11526*, *Sloanea 11217*, *Excoecaria 11209*, *Peperomia 11227* and **Flindersia chrysantha* Merr. & Perry represented rain-forest genera not found at higher levels.

Additional proof of the value of the oaks and *Castanopsis* as indicators of superior arable land was provided by their distribution in this locality. At the lower levels they, and their associate *Engelhardtia 11061*, were common throughout the forest as subsidiary trees of 25–30 m., and they survived as relics on cleared land. In a few places, between 2200 and 2350 m., these trees formed limited pure stands on the broad crests

of spurs, but none was encountered much above the upper limit of cultivation. Distinguished by their open character under the canopy, the dry appearance given by the slippery ground litter of cutinous dead leaves, and the virtual absence of ground moss between the trees, the oak-forests held few ferns, orchids or other herbaceous plants. *Rhododendron* 11057, with yellow flowers, was a common shrub, *Dimorphanthera* 11296, *Alyxia* 11300 and *Aeschynanthus* 11458 common among scrambling shrubs and climbers, *Drimys* 11295, *D.* 11294, *Ilex spicata* Bl.(?) and *Kania* 11292 characteristic small trees of the high undergrowth and substage. The oaks concerned were *Lithocarpus* 11353, *L.* 11396 and *L.* 11477. *Castanopsis* 11512 showed preference for the lower slopes.

Gradually the forests were being eaten into as the people of several village groups extended their communal clearings. Most of the producing gardens were on new land strewn with the trunks of large beech trees brought down by being burnt through at the base. Other trees, killed by fire or by ring-barking, stood as they had grown in the forest. The older parts of the cleared areas were occupied by *Imperata* grasslands and two distinct ecological types of seral or secondary forest.

New clearings in the lower forest zone were burnt over when the smaller timbers were dry enough to carry a good fire and the blackened ground immediately put under crop. Different methods were employed in the peaty upper forest zone, which to a small extent was being brought under cultivation. There, after the undergrowth was cleared and the trees felled, a period of some years of drying out and oxygenation by exposure to sun and wind seemed necessary to fit the soil for cultivation. On such seasoning plots there developed, as in openings in the mossy beech-forest at the 1800 m. Camp, a community of small trees and shrubs largely dominated by a species of *Rapanea* (No. 11288) from the undergrowth of neighbouring primary forest, and containing also *Kania* 11292, **Ilex Versteeghii* Merr. & Perry, *Eurya Tigang* Schum. & Lauterb., red *Rhododendron* 11293, yellow *R.* 11057, scrambling *Dimorphanthera* 11296, *Alyxia* 11577 and the scrambling bamboo No. 11072.

Seral growths of familiar lowland rain-forest type found suitable conditions for development on formerly cultivated soils of the lower forest zone. This complex vegetation exhibited many faces and phases in what would appear two main lines of development, one from *Imperata* grassland, the other a direct successional movement on abandoned gardens cleared from primary or secondary forest. On rocky grass slopes near the river, flat-topped *Maoutia?* 11075 and *Pipturus* 11390, sclerophyllous *Ficus* spp., scrambling *Rubus rosaeifolius* Sm., *R. Ledermannii* Focke

(?) and **Sticherus habbemensis* Copel. were followed by hardy representatives of the *Macaranga* complex. Higher on the slopes, on deep soils apparently long under grass, slender little *Buddleia* 11521 formed distinctive savanna-like stands in which *Dodonaea viscosa* (L.) Jacq. was chiefly responsible for setting up forest conditions. Succession on recently cleared forest land usually began with the replacement of garden weeds by dense 2 m. high growths of *Saccharum spontaneum* L. or **Cyathea pilulifera* Copel., or both. Characteristic species of the young forests that followed were *Macaranga* 11398, *M.* 11212, *Saurauia* 11208, *Homalanthus* 11561, *Dodonaea viscosa* (L.) Jacq., *Ficus* 11418, *Glochidion* 11074, *Piper* 11054, **Kibara laurifolia* A. C. Smith, *Schefflera* 11201 (forming a vaulted under layer on some rocky slopes), and scrambling or climbing *Rubus* spp., *Muehlenbeckia* 11205, *Polygonum* 11504 (at Lake Habbema and intermediate levels), *Clematis* 11235, *Lycopodium* 11204, **Sticherus habbemensis* Copel. and *Isachne albens* Trin.

Next in importance to *Imperata cylindrica* (L.) Beauv. in a meagre grassland flora of about 20 species were *Pollinia leptostachys* Pilg. and *Setaria geniculata* (Lam.) Beauv., which attained dominance on some dry slopes, and *Ischaemum digitatum* Brongn., which claimed the moister ground. Minor species included *Sporobolus elongatus* R. Br., *Isachne globosa* (Thunb.) Ktze., *I. micrantha* Merr., *Oxalis corniculata* L., *Calamintha* 11468, *Cynoglossum javanicum* Thunb. and climbing *Melothria* 11082. Characteristic of wet spots were *Juncus effusus* L., *Viola* 11371, and beds of *Leersia hexandra* Sw.

It was somewhat of a surprise to find in the gardens a species of *Bidens* (No. 11557) which, with the scarcely less aggressive *Polygonum* 11558, confronted the native cultivators with a serious problem in weed control. Scrambling over garden fences and soon taking possession of neglected village enclosures were *Oenanthë javanica* (Bl.) DC. and *Stellaria* 11582. Also plentiful as weeds about villages were *Rumex* 11387 and *Desmodium Scalpe* DC. Although not seen growing, *Solanum nigrum* L. was vended by the natives as a green vegetable, as were the young shoots of *Oenanthë*.

Riverbanks, and for that matter all kinds of open habitats in the forested mountains, provide special microclimates in which both lowland and highland plants are enabled greatly to extend their normal altitudinal range. This is discussed at length by van Steenis¹ in his exhaustive study of the origin of the Malaysian mountain flora. The occurrence of subalpine *Libocedrus* and species of *Rhododendron* and *Vaccinium*

¹Bull. Jard. Bot. Btzg. III. 13: 289-417. 1935.

in open dry habitats, far below their normal levels, is mentioned earlier in this paper. The lowest station observed for alpine grassland plants was at 2200 m. on the Bele River, where *Poa longiramea* Hitchc., *Brachypodium pubifolium* Hitchc., *Ranunculus* 11422 (also on forest paths) and *Hydrocotyle* 11307 grew on mossy rocks in the stream. These examples of abnormal vertical distribution are in accordance with general tendencies observed on the slopes of the Snow Mountains, namely, for plants of the alpine grasslands to reach their lowest, and lowland plants of the forests their upper limits, in open moist habitats, and, on the other hand, for lowland plants of the open grasslands to occur at their highest, and highland plants of the forest and scrub communities their lowest levels, in open dry habitats.

2800 M. CAMP, 9 KM. NORTHEAST OF LAKE HABBEMA

Collections were made here between October 8 and November 8, an off season for flowering at this altitude, and a time when few birds and mammals were breeding. The camp was in the bottom of the rather steep-falling little valley of one of the headwater streams of the Bele River. Sharp spur ridges, considerably lower than those that hemmed in the river basin, rose 50 to 100 m. from the bed of the stream on both sides. The country was entirely forested except for landslips along the streams, a few small clearings planted with *Pandanus* and containing native huts, and occasional wet shrubby openings which had probably been enlarged by the natives who used them for resting places when hunting and travelling in the mountains. Although well up in the cloud belt, weather conditions were variable, and mists not very frequent or regular in occurrence in the immediate neighbourhood. The tradewinds appeared to carry less moisture than at lower altitudes, and when they were in operation the clouds tended to mass on the high spurs, so that valley conditions prevailed in the river basin. Dull, overcast and showery weather was nevertheless the rule. For eight days beginning with November 1 the wind came from the northwest in a general disturbance which brought daily rain far heavier than was usual at other times. Two entirely clear days, and ten on which hours of sunshine ranged from approximately four to nine after 6 a.m., were experienced in the month. No less than nine days were without rain. Temperature: maximum (18 days) 13.5–21.5, mean 17.5, minimum (19 days) 4.5–10.0, mean 7 degrees Centigrade. Relative humidity: 6 a.m. (14 readings) 87%–94%, mean 93%, 1–2 p.m. in clear weather (5 readings) 44%–63%, mean 54% of saturation.

In this area of small spurs and valleys little better than ravines, the

separation of the *Nothofagus*-forests into a lower zone dominated by *N. 11103* and an upper zone of *N. 10243* was not well marked. The former was in control at 2700 m. on some spurs, the latter apparently almost sole dominant from 2800 m. up to 3100 m. The forest had many faces. In the usual splendid development, that clothed ridges and valleys alike, the dominants grew to 35–40 m. high and up to 1–1.5 m. in diameter above their spurred base, the tallest forest being found on the slopes. On occasional flat seepage-wet benches in the valleys, the rather stunted forests carried a thick layer of green bryophytes on the ground and lower tree-trunks and held few of the usual ferns and orchids. On narrow ridges, especially above 2850 m., the stand degenerated into a typical open "mossy-forest" 15 m. or less in height, with a deep ground cover of brownish hepatics and matted surface roots, the trees themselves blanketed and cushioned with mosses and hepatics and hung with pendent ferns and orchids to 5–8 m. of their length. In general, ground, trees and undergrowth were abundantly mossed down to 2600 m. or lower on the summits of spurs, and about 2700 m. in the valley bottoms. Collections were made between altitudes of 2600 and 3200 m., where numerous plants reached the upper or lower limits of their range. Most rain-forest species were restricted to moist bottoms or the lower slopes of ridges and few extended above the 2750 m. level. Of a total of approximately 50 trees of which at least some individuals attained a diameter of 25 cm. in primary or secondary forest, Coniferae furnished 4, Lauraceae 2, Cunoniaceae 5, *Elaeocarpus* 5, *Pygeum* 2 or 3, *Evodia* 2, *Melicope* 2, *Saurauia* 2 and *Pittosporum* 2 species.

The small amount of moss on the lower slopes, with the wet-tropical character of the vegetation on small flats along the stream up to 2750 m. in the camp valley, gave the forests there an appearance of rain-forest. The subsidiary trees *Garcinia Schraderi* Lauterb., *Ascarina* 10475, *Glochidion* 10495, *Laportea* 10485 and *Syzygium* 10498 represented rain-forest genera there at the upper limit of their altitudinal range. A very luxuriant undergrowth on moist flats, characterized by *Pilea* 10769, also contained *Alocasia* 10973 (to 2800 m.), subscandent *Piper* 10299 and *Cyrtandra* 10596, **Marattia coronata* Copel. with great fleshy fronds (2300–2800 m.), and the treeferns **Cyathea bidentata* Copel. and **Dicksonia Archboldii* Copel. Especially tropical in floristics and physiognomy were the seral growths in house clearings and other openings, where big-leaved *Macaranga* 10969 (to 2900 m.), *Saurauia* spp., *Homalanthus* 10297 (1 sp. at 3300 m.) and **Melicope mucronata* Merr. & Perry occurred as trees of 8–20 m., *Cypholophus* 10586, *Psychotria* 10989 and *Solanum* 10764 as small trees and shrubs, and *Tetrastigma Pullei* Lauterb. (to 2800 m.) and *Strongylodon* 10755 as climbers.

From about 2800 m. to 3100 m. the principal large subsidiary or sub-canopy trees were *Phyllocladus* 10528 (down to 2600 m.), a glaucous form (?) of *Podocarpus papuanus* Ridl. (No. 10513), long-leaved *P.* 10452, *Fagraea* 10541 and *Elaeocarpus* spp. Components of a conspicuous substage tree layer included *Xanthomyrtus* 10521 (particularly in low "mossy-forest"), *X.* 10584, *Rapanea* 10258, *Vaccinium minuticalcaratum* J. J. Sm., *Litsea* 10708, *Elaeocarpus* 10576 (along streams), *Schefflera* 10805 (also epiphytic), *Cephaloschefflera* 10997 and *Symplocos* 10707. Small-leaved *Xanthomyrtus* 11001, *Rapanea* 10849 and **Vaccinium debilescens* Sleumer, together with **V. otophyllum* Sleumer, *Rhododendron* 10250, *Styphelia nubicola* Wernh. and *Pygeum rigidum* Koehne (down to 2150 m.), formed a plentiful woody undergrowth in the open mossy forest of crests; *Pygeum*, *Amaracarpus?* 10522 and the tree-ferns **Cyathea everta* Copel. and **C. bidentata* Copel. were perhaps most characteristic of heavily shaded slopes; and restricted to valley bottoms was a set of small trees with larger leaves, such as *Symplocos* 10501, **Eurya habbemensis* Kobuski, *Drimys* 10570 and Araliaceae 10784. The only woody climbers in primary forest were **Ilex scabridula* Merr. & Perry, *Dimorphanthera* spp. (2) and **Freycinetia sterrophylla* Merr. & Perry. As woody epiphytes **Vaccinium oreomyrtus* Sleumer, several attractive *Rhododendron* spp. and *Myrmecodia* 10689 (in tree-tops) were common, while *Henslowia* spp. (2) and *Loranthus* spp. (3) occurred as parasites.

Everywhere rather poor in species, the herbaceous undergrowth of exposed crests consisted chiefly of tangled orchids, rooting in the moss; the ferns **Plagiogyria tuberculata* Copel., *Grammitis frigida* (Ridl.) Copel., **G. hispida* Copel. with variegated leaves, *Polypodium Werneri* Ros. and *Meringium rubellum* (Ros.) Copel. were common throughout on mossy ground; *Dryopteris Engleriana* Brause var. *hirta* C. Chr., *D. Wollastonii* (v. A. v. R.) C. Chr. (?), **Pteris macrophylla* Copel. and *Asplenium Foersteri* Ros. occurred with *Elatostema* spp. and a scattering of small Zingiberaceae in the valley bottoms. *Polypodium Werneri* Ros., *P. albidosquamatum* Bl., *Selliguea crassisora* (C. Chr.) Copel., *Calymmodon clavifer* (Hook.) Copel., *C. cucullatus* (Nees. & Bl.) Presl, *Ctenopteris taxodioides* (Baker) Copel., *C. millefolia* (Bl.) Copel., **Prosaptia Archboldii* Copel., **Grammitis habbemensis* Copel., **Xiphopteris antipodalis* Copel., *Mecodium bismarckianum* (Christ) Copel., *M. novoguineense* (Ros.) Copel., *Meringium gorgoneum* Copel., **M. Brassii* Copel., *M. rubellum* (Ros.) Copel., *Loxogramme subselliguea* (Baker) Alston, ***Lepidocaulon caudatum* Copel., *Humata kinabaluensis* Copel., and less commonly *Asplenium* spp., *Hymenolepis* spp. (including *H. validinervis*

Kunze, restricted to the leafy crowns of *Pandanus*) and *Elaphoglossum* spp., among ferns, and *Ceratostylis*, *Glomera*, *Mediocalcar*, *Phraetia* and *Dendrobium* species, among orchids, comprised the bulk of a very rich flora of moss-inhabiting epiphytes.

Frequent small openings in the tall valley forest from about camp level up to 2900 m., resulting from the fall of big trees affected by "dry rot," were claimed by communities which, owing to their mixed derivation, in the older stages were not always readily distinguished as secondary. Associated with invaders from the primary forest substage and high undergrowth were seral trees such as *Pittosporum ramiflorum* Zoll., *Acronychia murina* Ridl. (?), **Vaccinium obovalifolium* Sleumer (also at Lake Habbema), **Ilex Versteeghii* Merr. & Perry, *Evodia trichopetala* Lauterb., *Olearia* 10651 and *Timonius* 10642. Prominent in young growths were *Drimys* 10246, *Rhododendron* 10250 with big pink flowers, *R.* 10563 with red or yellow flowers, the scrambling shrubs *Coprosma* 10587, **Palmeria habbemensis* A. C. Smith and *Rubus Lorentzianus* Pulle, rambling *Polygonum* 10759, *Equisetum* 10756 and *Histiopteris incisa* (Thunb.) J. Sm., clumps of **Dryopteris spinosa* Copel. and showy *Languas* spp.

The seral communities of landslips along streams contained some peculiar floristic elements and a matter of 150 to 200 m. difference in altitude brought about striking changes in their constitution. The open parts of a large slip of crumbling marly limestone at 2780 m. altitude carried a short growth of *Schoenus?* 10923, *Imperata cylindrica* (L.) Beauv., *Viola* 10839 and the prostrate shrub Myrtaceae 10921, with which were associated alpine *Tetramolopium* 10914 and *Anaphalis* 10699. Around the edges *Gahnia* 10749 mingled with scrambling **Sticherus habbemensis* Copel., *Lycopodium cernuum* L. var. and *Equisetum* in low woody growths of *Rhododendron*, *Homalanthus*, *Coprosma*, *Rapanea* 10932 and especially *Myrica* 10938, which passed into a stand of *Xanthomyrtus* spp. and young *Nothofagus*. At 2600 m., where the camp valley narrowed into a ravine with very unstable slopes that showed exposures of a hard grey limestone, alpine plants, *Myrica* and *Coprosma* were absent, and *Pollinia leptostachys* Pilg., *Spathoglottis* 10866, *Dipteris novo-guineensis* Post., *Buddleia* 11521, *Astilbe* 10864 and the slender shrub **Hypericum habbemense* A. C. Smith reached the upper limit of their range on dry sunny parts of the landslips.

On stony beaches in the stream between 2700 and 2800 m. were found *Ranunculus* 10546, *Sagina?* 10552, *Epilobium* 10551 (also colonizing loose clay banks with the moss **Philonotis hamata* Bartr.), *Carex* spp. and **Trigonotis abata* Johnst. of the alpine grassland flora.

Other highland grassland plants such as **Potentilla novoguineensis* Merr. & Perry, *Luzula* 10737 and *Agrostis retrofracta* Willd. grew in a native house clearing at 2800 m., which was also the topmost station observed for a number of open ground plants of low altitudes, including *Setaria geniculata* (Lam.) Beauv., *Sacciolepis contracta* (Wight & Arn.) Hitchc., and the weeds of cultivation *Bidens* 11557, *Glossogyne latifolia* DC. and *Arthraxon hispidus* (Thunb.) Merr.

The only palms found on the slopes of the Snow Mountains were two species of *Calamus*, one common at 2200–2300 m., the other extending as high as 2650 m. There were but three species of Pandanaceae, **Freycinetia linearis* Merr. & Perry extending to 2600 m. and **F. sterrophylla* Merr. & Perry to 2850 m. in moist valley bottoms, and one large species of *Pandanus* (perhaps **P. brosimos* Merr. & Perry) which appeared to occur naturally in beech-forest up to 3000 m. and was cultivated for its seeds. A single example of another *Pandanus*, a striking clumped species with broad leaves and large ovate-cylindrical fruitheads, was seen in a garden in the Balim Valley, but could not be collected.

The following families reached the upper limit of their range in the 2800 m. camp locality: Cunoniaceae (*Quintinia* 11007, 3300 m.), Aquifoliaceae (**Ilex Versteeghii* Merr. & Perry, 2950 m.), Loganiaceae (*Fagraea* 10453, about 3000 m.), Euphorbiaceae (*Homalanthus* sp., to 3300 m.), Melastomataceae (*Memecylon* 10500, 2800 m.), Moraceae (*Ficus* 10783, 2700 m.), Gesneriaceae (*Cyrtandra* spp., to 2800 m.), Leguminosae (*Strongylodon* 10755, 2750 m.), Solanaceae (*Solanum* 10764, 2700 m.), Cucurbitaceae (*Melothria* 10621, 2800 m.), Sapindaceae (*Dodonaea viscosa* (L.) Jacq., 2650 m.); of genera not previously mentioned as at their upper limit, *Gunnera*, *Clematis*, *Adiantum*, *Lindsaya*, *Vittaria* and *Antrophyum* all dropped out between the 2700 m. and 2800 m. levels.

LAKE HABBEMA

At this camp, the first general collecting station of the expedition established inland, botanical collections were made between July 22 and September 4. Boiling point observations gave an altitude of 3225 m. for the lake surface. The upper end and much of the south shore of the lake were bordered by open marsh. Several timbered ridges touched on the north shore, where a deep bay provided a sheltered anchorage for the flying-boat and a good site for the camp. The season was most opportune for collecting. All but one of the flowering plants bore flowers or fruits or both, and all ferns and most bryophytes were in fertile condition.

The flight from Hollandia to the lake was made in about 90 minutes. At the beginning, most of the party were affected by the rarity of the air and the physiological upset occasioned by the sudden change in altitude. Breathing was difficult, and feet seemed weighted to the ground. In a few days, however, all but a very few had accommodated themselves to the new conditions. Despite warm clothing, good food and housing and an abundant supply of firewood, there was not much margin of comfort when, as it frequently did, the temperature fell below freezing point, and even the hardiest individuals felt the cold when afield in the chilling drizzle that accompanied the normal afternoon mist. On clear days, when the sun shone intensely bright and the rapid evaporation of high altitudes so dried the less sappy plants of the open ground that they crunched and broke underfoot, standard shade temperature rose as high as 21° Centigrade, while relative humidity fell as low as 33 per cent. Native personnel as well as Europeans were troubled with sunburn and cracked lips in the week of almost rainless weather that closed the month of July. A grass temperature of 36° was recorded on a sunny day on which maximum shade temperature reached only 18 degrees.

August was a month of inconstant weather in which rain fell on eighteen days, hail on three occasions, and there were two thunderstorms. Most of the rain fell during the afternoon and night. Only two days were wet throughout. Heavy fogs over the lake and its surroundings, of which there were twelve in August, lasting from before dawn to about 7:30 A.M., were followed almost invariably by bright sunshine until at least early afternoon. On such days the fog would be cleared by a slight southeast breeze, followed by a fitful east air, then a gusty northeast breeze that brought up dark driving clouds, mist and rain. A six day spell of bleak unsettled weather, with intermittent rain, came, however, from the southeast. No violent winds were experienced.

The frequent rains of August were sufficient to compensate evaporation and keep the peaty soil in a constant moist to wet condition, but there was little surface run-off. Receipts from drainage and precipitation on its surface failed to balance discharge and evaporation from the lake, the waters of which fell 20 cm. during this period, exposing beaches of sand and oozy mud, but were brought back to their former level by heavy rains during the afternoon and night of August 31.

Rainfall records were kept by the military party for the three months August to October. The records for August are not available. During September, measurable precipitations on 21 days gave a total of 284 mm. In October, falls of 4 to 25 mm. on 21 days totalled 258 mm.

Temperatures for the period July 26 to September 3 were: maximum

(37 days) 11–21, mean 18, minimum (38 days) minus 3—plus 4.5, mean 1.1 degrees Centigrade. There were 14 minimum readings of zero Centigrade or lower. Diurnal variation ranged from 10 to 22.5 degrees, as compared with 6.5 to 14 degrees for the 2800 m. Camp. Readings of relative humidity were made for the purpose of ascertaining extreme rather than average conditions. It was found to range from 92% to 100% at 6.30 a.m., and from 76% to 82% at 6 p.m. (sundown). In dry sunny weather, readings of 33% to 59% were obtained at noon, and 46% to 58% at 1 p.m.

Sandstones alternated with limestones from the Grand Valley of the Balim River to the highest parts of the Snow Mountains. For the most part the rock of the Lake Habbema area was a pale greyish sandstone. Large boulders of sandstone lay strewn on the lower slopes of some of the ridges, it showed frequently in little hillocks, and there were massive exposures on the parallel ridge on the south side of the lake. That limestone was also present was indicated by rather numerous sinkholes on the ridges. Irrespective of plant cover and rock formation, the mineral soils of the whole area were covered by peats.

Closed forest in this locality was strictly confined to the ridges. It developed in patches, sometimes very small, occasionally up to one or even two hundred metres in length and breadth. These patches usually occurred in association with limestone. Not all limestone sinkholes were in closed forest, but in nearly every patch of closed forest, however small, could be found at least one sinkhole. In at least some of the forest patches the surface layer of peaty material rested on yellow clay. There were two distinct tree strata, the upper approximately twice the height of the lower. The upper tree layer consisted of a generally open stand of *Libocedrus* 9241, *Phyllocladus* 9058, and especially *Podocarpus papuanus* Ridl., usually 12–15 m. high and up to 50 cm. in diameter, in which occurred *Podocarpus* 9341 and, appearing much out of place in its surroundings, *Schefflera* 9091 with glossy rayed leaves and large red inflorescences terminating its branches. Dominating the forest and constituting most of the lower tree layer was **Vaccinium dominans* Sleumer, which with *V. minuticalcaratum* J. J. Sm., **V. obovalifolium* Sleumer, *Rapanea* 9550, *R.* 9080, *Symplocos* 9340, **Pygeum retusum* Merr. & Perry, *Elaeocarpus* 9092, *Litsea* 9559, *Xanthomyrtus* 9018 and *Timonius* 9504 as minor dominants, and *Xanthomyrtus* 9018, *Olearia* 9146, *O.* 9143 and *Saurauia* 9140 occurring chiefly about the edges, formed a dense low canopy under the conifers. Often the trees of the lower layer branched at ground level and should perhaps be called shrubs. Most of them had crooked or leaning, finally

upright stems and branches, erect branchlets, and crowded thick leaves entirely smooth or pubescent on the under side. Under closed canopy conditions, the forest interior presented a dim monotony of shaggy tree trunks but slightly relieved by a few small epiphytic ferns and still fewer ground ferns and shrubs. Thinner than in the stunted *Nothofagus*-forest of lower levels, owing to the dense canopy, here, too, the bryophyte cover on ground and trees consisted mainly of hepatics. The shade-loving tree ferns *Dicksonia Hieronymi* Brause and **Cyathea costalisora* Copel. appeared in a sparse tall undergrowth in which *Drimys* 9362, *Pittosporum ramiflorum* Zoll., **Vaccinium debilescens* Sleumer, *Acronychia murina* Ridl. (?), *Cephaloschefflera* 9377 and red-flowering *Rhododendron* 9141 showed preference for better lighted conditions. Good lighting permitted the development of a plentiful herbaceous undergrowth of *Urticaceae* 9292 and *Pilea* 9293, 50 cm. high, while under heavy shade the ferns *Meringium rubellum* (Ros.) Copel., *Selliguea Feei* Bory, *Ctenopteris allocata* (v. A. v. R.) Copel., *Grammitis integra* (Brause) Copel., *Dryopteris hypolepioides* Ros., **D. habbemensis* Copel. and *Athryium japonicum* (Thunb.) Copel. grew from the ground moss. The only climbers were *Dimorphanthera* 9363 with large palatable fruit, *Rubus Lorentzianus* Pulle and *Piper* 9134, which scrambled about the borders and appeared under breaks in the canopy. Pendent tuft ferns such as *Ctenopteris pendens* (Ros.) Copel., **C. bipinnata* Copel., **C. Brassii* Copel., *C. whartonianiana* (C. Chr.) Copel. and *Calymmodon cucullatus* (Nees & Bl.) Presl, the Hymenophyllaceae *Meringium rubellum* (Ros.) Copel., *M. Brassii* (C. Chr.) Copel., *Microtrichomanes digitatum* (Sw.) Copel. and *Mecodium imbricatum* (Bl.) Copel., *Grammitis subrepanda* (Brause) Copel., *G. integra* (Brause) Copel., *G. knutsfordiana* (Baker) Copel., *Selliguea Feei* Bory, *Asplenium hapalophyllum* Ros., *A. setisectum* Bl. and *Polystichum alpinum* Ros., a few orchid species, and the shrubs **Vaccinium debilescens* Sleumer, *Rhododendron* 9486 and *Hydnophytum* 9506 supplied the epiphytic flora. *Loranthus* 9361 was a common parasite under the canopy.

Shutting out from the forest the strong light and drying wind of the grasslands, and forming a living firebreak, was a compact wall of upright shrubs 1.5–2 m. high, which had to be forced apart or cut through to gain the forest interior. Associated with ericoid *Styphelia Vandewateri* Wernh. and *Rhododendron* 9024, which formed the bulk of the border shrubberies, were other *Rhododendron* spp., *Drimys* 9068, straggling *Coprosma* 9028 and *C. 9144*, rooting in deep beds of **Macromitrium altipapillosum* Bartr. and other mosses. Prominent in this very narrow ecotone were the quaint xerophytic tree ferns **Cyathea*

tomentosissima Copel. and occasionally **C. cheilanthoides* Copel., and on its grassy outer edge grew the herbs *Stellaria* 9122, *Acaena anserinifolia* (Forst.) Domin, *Myosotis saruwagedica* Schltr., *Libertia* 9216 and silver-grey *Potentilla papuana* Focke. Sometimes, on borders disturbed by fire, gradated shrubberies of *Coprosma*, *Rubus paradoxus* Ridl., *R. Ferdinandi-Muelleri* Focke, *Hypericum Macgregorii* F. v. Muell., etc., extended out on to the grassland.

Closed forest, as described, occupied but a small part of the wooded ridges in the Lake Habbema area. The prevailing tree communities of the sandstone ridges, which approached the open grasslands of the valleys and hollows in extent, were at best an open forest of smut-darkened *Libocedrus* and *Podocarpus papuanus*, and on basal slopes often no more than a low savanna stand of *Libocedrus* alone. Fastigate and symmetrical when young, the *Libocedrus* trees assumed distorted shapes in age, when their bizarre appearance was heightened by gouty *Myrmecodia* spp., which occurred everywhere as epiphytes on the conifers and also grew on the ground. Golden-brown and purplish bryophytes on the trees, and brilliant little *Dendrobium* spp. with orange, red, green or purple flowers, provided patches of colour. The ground vegetation which controlled the habitat in these forest successional or subclimax communities ranged from dwarf bog grasses and herbs to long tussock grasses, ericoid shrubberies and scrubs of broad-leaved trees stunted to the stature of shrubs. Pits dug in the shrubberies went through 20 to 50 cm. of peat before encountering a bleached subsoil of grey sand containing fragments of the parent sandstone.

Like the closed forests developed about limestone sinkholes, the scrubby low-tree thickets were much interrupted and fragmented by glades. Generally 2-3 m. high, very dense and rigid, heavily overgrown with hepatics and lichens, and half buried in the orange-brown ground mosses **Macromitrium altipapillosum* Bartr. and *Schlotheimia pilicalyx* Broth. & Geh., their chief components were *Xanthomyrtus* 9018, **Vaccinium dominans* Sleumer (major dominant of closed forest), **V. oreites* Sleumer, *Phyllocladus* 9058, **Pygeum retusum* Merr. & Perry and *Rapanea* 9080. *Schefflera* 9091 was conspicuous as a tree of 4-6 m. Abundant as climbers were *Tecomanthe?* 9052, with great pink flowers, and *Alyxia* 9114. Characteristic of the edges were *Pittosporum pullifolium* Burk., *Drimys* 9068 and *Rhododendron* spp. as tall shrubs, subprostrate **Vaccinium chionostomum* Sleumer and *Symplocos* 9019, *Trachymene* 9064, and masses of *Blechnum Hieronymi* Brause. Under favourable light conditions, small orchids and such ferns as **Polypodium crassimarginatum* Copel., *P. lamphrophyllum* C. Chr., *Dryopteris oligo-*

lepis v. A. v. R., *Selliguea crassisora* (C. Chr.) Copel., *Hymenolepis revoluta* Bl., **Elaphoglossum fuscum* Copel., **Grammitis graminifolia* Copel. and *Meringium rubellum* (Ros.) Copel. abounded in the ground moss. There was a remarkable wealth of epiphytic ferns such as *Selliguea Feei* Bory, *Grammitis scabristipes* (Baker) Copel., *Polypodium subundulatum* Ros., *Ctenopteris whartoniana* (C. Chr.) Copel., *Merinium Brassii* (C. Chr.) Copel. and **Humata Brassii* Copel., and especially of orchids, which included numerous *Bulbophyllum* spp. and showy *Dendrobium* spp.

Best developed in glades between low-tree thickets, and seldom extending far beyond the territory of the conifers, the ericoid shrubberies as a rule consisted of nearly pure greyish stands of *Rhododendron* 9130, a major dominant of the shrubberies fringing closed forest, and a species found in open sandy habitats down to 2100 m. in the Balim Valley. Common associates included *Styphelia obtusifolia* J. J. Sm. var. *hypoleuca* J. J. Sm., *Rapanea* 9080, *Tetramolopium* 9025 and *Rhododendron* spp. as shrubs 0.5 to over 1 m. high, *Myrmecodia* spp. and the large clump sedge *Gahnia* 9047. Dwarf *Oreobolus* 9244, found everywhere on open peaty ground, and creeping *Lycopodium* spp. provided a stiff soil cover. In some dry situations the heath-like shrubs were replaced by prostrate *Xanthomyrtus* 9074, *Symplocos* 9019 and *Gaultheria* 9051, or *Cladonia* and other lichens carpeted the ground. On dry points of ridges jutting into grassland, the shrubberies sometimes ended in dense growths of erect **Gleichenia squamosissima* Copel. and *Kelleria papuana* Domke, 20–30 cm. high.

Treeless grasslands occupied, besides the broad valleys and the basal slopes of the ridges rising from them, all the lateral hollows and numerous glades in the forests. The widest tract — that of the Balim-Wamena valley — was 4 km. across. The most important factors influencing their distribution would appear to be temperature and cold air drainage from the heights. Edaphic conditions and vegetation cover, on the wooded ridges as well as in the valleys, must be regarded as expressions of the climate. If climatic conditions in the area were uniformly suitable for the development of forest, forests could be expected to cover all but the marshes and rocky barrens. There was no evidence of any great expansion of the grasslands as a result of forest fires.

There were two types of grassland, readily separable on gross appearances, but in all but a few situations especially superior or inferior as regards soil conditions, comprised of approximately the same species — one a community of tall grasses, the other of dwarf grasses and sedges. Not often did one find the tall grasses unaccompanied by dwarf species,

and vice versa. The long-grass community, dominated by tussock-forming *Deschampsia Klossii* Ridl., developed as a distinct ecological unit on well drained soil about the forest edges, on the often somewhat elevated sandy banks of the deeply entrenched little streams that wound through the valleys, and on areas patently deforested by fire. Among the few grasses associated with the metre high dominant were *Hierochloë redolens* R. Br., *H. angusta* Hitchc., No. 9050, *Festuca nubigena* Jungh. and *Brachypodium pubifolium* Hitchc.; clumped *Gahnia* 9047 occurred commonly throughout. Characteristic herbs included *Stellaria* 9122, *Myosotis saruwagedica* Schltr., *Potentilla papuana* Focke, *Acaena anserinifolia* (Forst.) Domin, *Erechtites* 9552 and (locally) *Keysseria* 9209. Along the streams were found the small herbs *Trigonotis papuana* (Hemsl.) Johnst., *Oreomyrrhis* 9323, *Galium* 9321, *Plantago* 9457, *Hydrocotyle* 9320 and *Hypericum japonicum* Thunb., *Luzula* 9175, and several small sedges and grasses. Areas of quaking bog also supported more or less closed communities of tall *Deschampsia*, with *Astelia* 9188 in grey mats and cushions, *Ranunculus* 9589 and other herbs, *Marchantia* sp. and *Sphagnum* sp. covering the ground in the interstices between the grass clumps.

Nearly everywhere in the short-grass community tufts of *Deschampsia*, 25–50 cm. high, grew from the close mat of rigid dwarf grasses and sedges that covered the ground. This community was typically developed on somewhat boggy flats and slopes and on the dry soil of treeless low ridges in the valleys. It appeared to occupy chiefly stations unsuited for the development of the long-grass community, which it greatly exceeded in total area. Only two to five centimetres high, the dominant *Monostachya oreoboloides* (F. v. M.) Hitchc., No. 9185, *Aulacolepis* 9554 and *Oreobolus* 9244 formed a fairly continuous cover on a ground surface smooth or somewhat bumpy with little pot-holes in which water lay after rain. This "bog-turf" was rich in mostly rosette-forming small herbs such as *Ischnea* 9177, *Gnaphalium* 9205, *Ranunculus* spp., *Lactuca* 9193, *Potentilla Forsteriana* var. *Keysseri* Diels, **P. habbemana* Merr. & Perry, *Gentiana* 9180, *Euphrasia* 9192, *Geranium papuanum* var. *alpestre* Ridl., *Plantago* spp., *Eriocaulon* spp., *Drosera* 9195, *Epilobium* 9206 and *Halorrhagis* 9194, and *Sagina* 9233 and *Centrolepis* 9173 were common cushion plants. Although *Sphagnum* was usually absent, mosses such as **Bryum longidecurrens* Bartr., **Ectropothecium palustre* Bartr. and *Meesea triquetra* (Hook. & Tayl.) Aongstr. often took possession of seepage areas, and grey and black lichens and a dark brown hepatic were plentiful on the ground.

While common enough, generally grouped together, and showing a

preference for the drier ridges and banks of streams, shrubs were seldom conspicuous on the grasslands. Some, such as prostrate *Vaccinium ciliatipetalum* J. J. Sm. and *Styphelia Dekockii* J. J. Sm., were restricted to the short-grass mat, and *Rhododendron* 10184 formed large cushions on wet ground. As shrubs of 25–50 cm., *Drimys* 9068, *Symplocos* 9518, *Eurya Brassii* Kobuski, *Hypericum Macgregorii* F. v. Muell. and *Tetramolopium* 9349 occurred chiefly with the long-grasses, as did the fire-resistant tree-ferns *Cyathea tomentosissima* and *C. cheilanthoides*, abundant on ridges and along the streams.

Marshes of considerable extent spread back from the upper end, much of the south shore, and part of the northern bay of the lake. Forming a lipped edge where the marshes touched on the lake, were deep soft beds of peaty material which, when walked on, yielded as if afloat. The marsh vegetation consisted of a thick stand of *Deschampsia* and *Scirpus* 9443, a metre or more high. The outlet stream of the lake, which flowed wide and deep before dropping away in rapids, was also edged with *Scirpus* beds and tall *Carex* 9211, and contained quantities of submerged *Potamogeton* 9513. Plentifully tufted in sandy marginal shallows of the lake were *Isoetes* 9441 and especially *I.* 9440.

MOUNT WILHELMINA

The route followed from Lake Habbema Camp to Mt. Wilhelmina led for three hours almost due south from the grass valley of the lake over a lightly timbered ridge and across the broad Balim-Wamena plain. From the Wamena River, which rises high on the north slopes of Mt. Wilhelmina, and was crossed at an altitude of 3150 m., a native path was followed in a general southeasterly direction on to a limestone ridge that carried forest dominated by *Podocarpus-Libocedrus* and superior to any near Lake Habbema, and into a narrow grass valley in which six hours of travel with carriers from the lake camp brought one to an altitude of 3400 m. There an intermediate transport camp, called Tusschen-bivak, was established. The stream that flowed past Tusschen-bivak disappeared in limestone in at least one place, and a half-hour below the camp the path skirted the brink of a large sinkhole, the upper sides of which exposed a deposit of what looked like glacial till. Prominent on the steep forested ridges that hemmed in the valley were the bunched crowns of slender *Schefflera* trees that stuck out like mops against the sky. Although no fresh soil exposures were observed, the forests evidently had suffered considerable disturbance from landslips, and the presence of numerous dead old conifers and well grown

young trees probably indicated that, many years before, parts of the forest were ravaged by fire.

Still leading approximately southeast from Tusschen-bivak, the native path climbed over a ridge into a smaller grass valley, from the head of which, at 3480 m., it dropped down into the long, grassy, north-south valley in which the mountain base camp was situated at 3560 m., 5½ carrier hours from Tusschen-bivak, and about 7 km. northeast of the summit of Mt. Wilhelmina. A half-hour below the camp, the stream that drained the valley passed underground through a low transverse ridge of limestone. This ridge, with a 50 m. precipice of limestone that crossed the valley within gunshot of the camp, formed a sheltered pocket about 1 km. long and half as wide, with high timbered ridges on both sides and a wet bottom in which were some open swamps to which innumerable slender grass tufts growing erect in the water gave the appearance of rice fields. Only one *Libocedrus* tree was seen after entering the valley. The limit of the conifers had been passed. The forests were getting lower, much cut by glades, and the tops of nearby 3900 m. and 4000 m. peaks were without trees. The camp was on a long slope of landslide debris covered with grass tussocks. Generally, the slopes were considerably disturbed by slips and subsidences, and the soil peaty and immature. Botanical collections were made here between September 7 and 16.

From a cavern at the foot of the limestone precipice, issued the stream that flowed down the base camp valley, and from the rim of the precipice the valley continued in a southerly direction toward the crest of the range. At 3650 m. was a lake, about 400 m. long and 300 m. wide, about which patches of forest had been burned and parts of the grassland appeared formerly to have been forested. From a rather marshy flat at the head of the lake a steep climb up a wooded sandstone declivity brought one, at 3800 m., to the open top of a rocky saddle, the crest of the range and the divide between the Balim waters and those flowing directly to the south. From here a view was had of the quick-falling southern slopes, a view limited by the projecting summit ridge of Mt. Wilhelmina, which towered parallel a kilometre still farther to the south and west. The path, which dropped to the south, was left at this point, and in a sheltered hollow at the foot of a waterfall 0.5 km. to the west, about 2 km. from the snow-capped summit of the peak, and three carrier hours from the 3560 m. Camp, a climbing base and the highest collecting camp was established at 3800 m. Above the waterfall, talus slopes of grey-white limestone on the south side of a V-shaped east-west valley gave the camp its name of Puindal or Scree Valley

Camp. On the north side of Scree Valley a ridge of largely bare sandstone rose in a false peak about 4300 m. high. On a saddle at the head of the valley, from which the north face of Mt. Wilhelmina proper rose in almost a sheer face of limestone to 4750 m., was a small lake at an elevation of 4150 m.

From Scree Valley Camp, between September 17 and 27, plant collections were made at altitudes up to 4300 m. on the summit ridge of Mt. Wilhelmina, down its south slopes to 4000 m., and down the waterfall creek to 3700 m. Some few plants occurred on the south slopes which were not found on the north side of the range.

Scree Valley Camp was at the highest elevation at which a few sticks long enough for tent poles could be had. From Lake Habbema up to the vicinity of the 3650 m. lake, the largest areas and best development of forest occurred in association with limestone. Above that, such forest as there was consisted of strips under sheltering bluffs and compact little clumps of trees on the rocky slopes and crests of ridges. Scattered, bushy tree clumps straggled up to about 4000 m. Absolute tree limit was reached at 4050 m., in the shelter of a north-facing sandstone bluff on the false peak. The only large woody plant above that level was *Coprosma* 9939, a shrub of 1-1.5 m., dotted over tussock grass slopes up to 4150 m. on the summit ridge of the mountain. This *Coprosma* ranged up to a similar level on the south slopes, where the last patch of stunted trees was at an altitude of 4000 m. The tussock grass *Deschampsia Klossii* Ridl. still flourished among limestone rocks at 4300 m. on the crest of the summit ridge. Under rocks at 4500 m. Archbold and Rand found the small grass *Festuca* 10206 and tufts of *Oreomyrrhis?* 10082, the only flowering plants seen by them at that altitude. But on the false peak, tiny grey rosettes of *Plantago* 10135 practically replaced even the ubiquitous dwarf grass *Monostachya oreoboloides* (F. v. M.) Hitchc. as low as 4150 m., where the most striking feature of the vegetation was the patched though abundant covering of brown, yellow and green bryophytes, including among mosses *Schlotheimia pilicalyx* Broth. & Geh., *Holomitrium cirrosum* Bartr., *Atractylocarpus dicranoides* Dix. and *Distichium capillaceum* (Hedw.) Bry. Eur., that grew on sheltered faces of the soft sandstone rock.

The path followed from the Wamena to near Scree Valley Camp bore signs of long use, and in several places was cut shoulder deep in the ground. Here and there, in the shelter of the forests, were native shelters, the better ones in the conifer zone made of *Libocedrus* bark. Higher up they were of boughs, treefern fronds and grass. From 3560 m.

upwards the natives camped under rocks, and built no shelters. In the ashes of such a rock camp under the cliff at 3560 m. were found charred fragments of human bones, and in a niche in the rock were parts of a skull and a femur, wrapped in bark.¹ A line of stones, laid along a comb of rock in the 3800 m. pass, marked the spot where the path topped the range. No native paths or camps were encountered above this altitude, and from the fact that, in Scree Valley, tin cans, a bottle stopper and other articles likely to be picked up by primitive people were found on the site of a camp used 13 years before by the Kremer Expedition, it would seem that the native travellers did not venture far from the path at this high crossing. Their motive in crossing the range could not be ascertained. Men, women and children, in parties of from four or five to over a hundred, made the journey, carrying bundles and sometimes leading pigs as though on a trading expedition, a visit to friends, or a dance on the opposite slopes. These journeys were carried out regardless of weather conditions. Hunting was not the object, although ducks were shot with bow and arrow on the lakes, and from Lake Habbema up to about 3600 m. on the range were found deadfalls made by the natives to catch the bandicoots (*Peroryctes*) and the very large rats (*Mallomys*) that inhabited the grasslands and forest borders.

A spell of very wet misty weather prevailed throughout the stay of the expedition at both camps on the slopes of Mt. Wilhelmina. These conditions, which curtailed all field activities and rendered impossible the ascent of the peak, began on August 31 and continued until October 7. Both grasslands and forests were in a state of constant saturation. On the rare clear mornings, when grass temperatures of minus 5° Centigrade were registered at the 3560 m. Camp, the trampled slush of the paths froze solid, and the bare rock of the summit ridge glistened white with ice. Snow, which normally covered but the tip of the peak, on one occasion lay as low as 4250 m. on its slopes. The following standard temperatures were recorded at the 3560 m. Camp from September 10 to 22, inclusive: maximum (8 readings) 10.5–17, mean 13.5, minimum (8 readings) minus 2–plus 2.5, mean zero Centigrade.

But for a steady falling off in total number of species and the acquisition of a few new ones with increasing altitude, the forests of the Mt. Wilhelmina slopes were essentially similar to those of the Lake Habbema area, and **Vaccinium dominans* Sleumer continued in the role of a major dominant to near timber line. They differed chiefly in the absence of conifers which, having attained dominance at about

¹The people of the Balim Valley cremate their dead.

3150–3200 m. on a limestone ridge above the Wamena River, dropped out of the picture at an altitude of approximately 3500 m. (The dominant position of *Podocarpus papuanus* Ridl. down to 3100 m. on the relatively warm slopes of the Bele River basin to the northeast of Lake Habbema was mentioned on page 278). The disappearance of the conifers was all the more remarkable in that their place as characteristic overtopping trees was usurped by the Araliaceae; first by *Schefflera* 9091, and above 3700 m. by *No.* 9424, which persisted to nearly 3800 m.

From about 3500 m. to 3700 m. on the slopes, **Vaccinium dominans* Sleumer dominated in dense, low, often wind-clipped forest, at most 5–6 m. high, in which *Rapanea* 9936 became increasingly important with altitude and *Symplocos* 9912, *Eurya Brassii* var. *erecta* Kobuski, *Xanthomyrtus* 9904, *Vaccinium quinquesidum* var. *oranjense* J. J. Sm. and *Olearia* 9968 occurred as minor dominants. *Saurauia* 9952 grew on the face of the cliff at 3560 m. This forest was without woody climbers. In a sparse undergrowth there was but one shrub, *Vaccinium densifolium* J. J. Sm., and *Uncinia* 9847 associated with occasional ferns such as **Hypolepis Archboldii* Copel., **Polystichum Archboldii* Copel., *Grammitis scabristipes* (Baker) Copel. and abundant creeping *Selliguea Feei* Bory in a thick cover of ground mosses. *Selliguea Feei* was also abundant as an epiphyte in the forest interior, pendent from the heavily moss-padded tree trunks in association with massed *Meringium Forsteri* (Ros.) Copel., **M. melanosorum* Copel., *Asplenium Brassii* C. Chr. and *Ctenopteris pendens* (Ros.) Copel., tufted *C. bipinnatifida* (Baker) Copel., *C. whartonia* (C. Chr.) Copel., *Grammitis mollipoda* (Baker) Copel., *G. novoguineensis* Copel., **G. stomatocarpa* Copel., **G. plurisetulosa* and **Calymmodon fragilis* Copel. The few orchids, of which the fiery red *Dendrobium* 9953 alone was conspicuous, occurred as small epiphytes about the edges with *Lycopodium* 9896, pendent *Galium* 9859, and the matted shrubs *Vaccinium oranjense* J. J. Sm. and *V.* 9907. Among hepatics and lichens on exposed upper branches were found **Ctenopteris Myer-Dreesii* Copel. and **C. fusca* Copel. Mosses, of which **Holomitrium cirrosum* Bartr., *Schlotheimia pilicalyx* Broth. & Geh., *Dicranoloma Blumii* (Nees) Par., *D. arjakianum* (C. M.) Broth. and *Macrothamnium hylocomioides* Bartr. were most abundant and characteristic among many species, predominated over hepatics on both trees and ground under the canopy of these upper subalpine forests. Conspicuous in the narrow marginal shrubberies, in which showy red or yellow *Rhododendron* 9833 was characteristic, and ericoid *R.* 9024 of Lake Habbema, *Styphelia nubicola* Wernh., *S. obtusifolia* var. *hypoleuca*

J. J. Sm., *Vaccinium densifolium* J. J. Sm., *Olearia* 9832, *Pittosporum pullifolium* Burk. and brownish *Coprosma* 9842 (which appeared at 3400 m.) also plentiful as shrubs of 1–2.5 m., were **Cyathea tomentosissima* Copel. and almost glabrous *C. Muelleri* Baker, which largely replaced it at this altitude. Gregarious in the shrubberies were the erect ferns *Blechnum Hieronymi* Brause and *Hymenolepis revoluta* Bl., and **Potentilla novoguineensis* Merr. & Perry, *Keysseria* 9837, *Veronica* 9861 and **Trigonotis abata* Johnst. entered from the grassland.

In the highest strip of real forest, that at Scree Valley Camp, tree species were reduced to five—**Vaccinium dominans* Sleumer and *Rapanea* 9936 in control, *Drimys* 10111, *Olearia* 10110 and *Pittosporum pullifolium* Burk. (commonly arborescent). Very heavily mossed on trees and ground with chiefly **Macromitrium Archboldii* Bartr. and **Holomitrium cirrosum* Bartr., the epiphytic flora consisted of *Meringium Forsteri* (Ros.) Copel., **Calymmodon fragilis* Copel., **Grammitis plurisetulosa* Copel., **G. debilifolia* Copel. and *Selliguea Feei* Bory, all common, and the latter the only ground fern. In the border shrubberies were *Rhododendron* 9833, *Coprosma* 9842, *C.* 9939, *Styphelia obtusifolia* var. *hypoleuca* J. J. Sm., *S. nubicola* Wernh. and *Symplocos* 9937. The bushy tree clumps above about 3900 m. were of *Rapanea* and *Drimys*, which, stunted to shrubs, formed with *Rhododendron* 9833 and *Coprosma* 9939 the scattered scrubs in which forest species reached their uppermost limit at 4050 m.

Up to the highest levels examined on Mt. Wilhelmina, the grasslands retained the general characteristics presented at Lake Habbema. *Deschampsia Klossii* Ridl. maintained its position as major dominant of the long-grass community, and *Monostachya oreoboloides* (F. v. M.) Hitchc. was chief dominant of the short-grass community. The Mt. Wilhelmina grasslands were, however, much richer in species. While certain plants of the lower levels dropped out on the slopes, there was nevertheless a steady gain in the total number of herbs and particularly of Compositae and grasses up to about 4000 m., above which elevation few new elements appeared and species diminished rapidly in number and for the most part also in abundance. A noteworthy feature was the part played by mosses, massed in brown or yellow cushions or distributed through the grasses, many of which also occurred in the forests. Among the most remarkable mosses were *Tetraplodon Lamii* Reimers, generally found on the faeces of wild dogs, and **Holomitrium austroalpinum* Bartr., which formed, usually on the bleak crests of ridges, knee-high cylindrical cushions that reminded one of the distance markers along a highway.

In the long-grass community *Gahnia* 9047 occurred about forest edges up to about 3700 m., and co-dominant, locally dominant or associate grasses with the *Deschampsia* included *No.* 9928, *No.* 9945, *Festuca nubigena* Jungh., *Calamagrostis Brassii* Hitchc., *Hierochloë redolens* R. Br., *Poa Brassii* Hitchc. on forest edges, *Brachypodium pubifolium* Hitchc., and *Danthonia Archboldii* Hitchc. With *Monostachya oreoboloides* as co-dominants were *Poa crassicaulis* Pilg. and *Oreobolus* 9244. Among herbs, most of which occurred in association with both long and short grasses, were cushioned *Potentilla Forsteriana* Lauterb. var. *Keysseri* Diels, *Astelia* 9188, *Centrolepis* 10022 and *Eriocaulon* 9956, *Keysseria* 9837, *K.* 10208, **Trigonotis abata* Johnst., *T. papuana* (Hemsl.) Johnst., *Veronica* 9861, *Trachymene* 10019, *Gentiana* 9990, *G.* 9866, *Euphrasia* 9971, *Papuzilla* 10053 (above 3800 m.), *Ranunculus* 10220, *R.* 9867, **Potentilla Archboldii* Merr. & Perry, **P. Brassii* Merr. & Perry, *Pilea* 10242, several *Plantago* spp., *Ischnea* 10039, *Gnaphalium* 10216 and numbers of other dwarf Compositae.

Restricted to the grassy banks of streams were **Wahlenbergia confusa* Merr. & Perry (up to 3500 m.), *Oxalis magellanica* Forst., *Nertera* 9397 and *Geranium monticola* Ridl. Common lithophytes included massed and pendent *Epilobium* 10015 and *Coprosma* 9831 (a shrub) up to 3600 m., *Papuzilla* 10053, and the ferns *Polystichum alpinum* C. Chr., **Blechnum nudius* Copel. and *Mecodium ooides* (F. v. M. & Baker) Copel. Pioneers of the screes at 3900 m. to 4100 m. included tufted *Anaphalis* 10048 and *Epilobium* 10043, and a notable group of prostrate and ascending, pubescent, semi-woody small Compositae (*Tetramolopium?*), e.g. *No.* 10047, *No.* 10049, *No.* 10050, also found on weathering rock surfaces. Common as weeds of the native rock shelters were *Agrostis retrofracta* Willd., Urticaceae 9826 and robust *Anaphalis* 10115.

As grassland shrubs up to 1 m. high, *Symplocos* 10127 and *Eurya Brassii* var. *erecta* Kobuski, and *Rhododendron* 10184 in large cushions, were common up to about tree limit, and *Coprosma* 9939, as already mentioned, conspicuous as a larger shrub up to 4150 m. Between the upper limit of the *Coprosma* and the 4300 m. level several *Hebe* spp. (a genus which first appeared at 3440 m.), *Tetramolopium* 10183 and *Styphelia obtusifolia* var. *hypoleuca* J. J. Sm. occurred abundantly as shrubs of 20–30 cm., and among *Rhododendrons*, a genus richly represented in the alpine and subalpine zones, may be mentioned *R.* 9917 with showy red flowers, and the striking red and yellow *R.* 9916.

The tree-fern *Cyathea Muelleri* Baker, of which only one clump was seen at Lake Habbema, became very abundant with **C. tomentosissima* Copel. on the grasslands and especially in forest-bordering shrubberies

and forest burn communities at about 3500 m., but both reached the extreme upper limit of their range at 3700 m.

EFFECTS OF FIRE AT HIGH ALTITUDES

No fire destructive to forest had occurred in the Lake Habbema area or on the slopes of Mt. Wilhelmina for some years prior to the visit of the expedition. A fire lit by natives at Lake Habbema, during the stay of the expedition, swept over several acres of long grass and, burning to the forest edge on a 200 m. face, no more than scorched the bordering shrubs. Another fire, which entered some low-tree thickets, completely denuded the trees of leaves, but burned only the surface of the deep ground moss. There was no opportunity to observe whether the trees lived or died after the latter fire. But wherever there were grasslands, from Lake Habbema up to an elevation of 3650 m. on Mt. Wilhelmina, there was abundant evidence of former fires destructive to forest, affecting in all cases only small areas, and always close to native paths.

The remarkably hardy native travellers who, naked, or with at most a hood of *Pandanus* leaves covering head and shoulders, journey over the highlands, move at a smart pace and make frequent stops to rest. The prevailing temperatures are such as to encourage haste, while the rarity of the air makes long continued exertion impossible. In forest, natural glades are used as resting places and sites for shelters, or clearings made for the purpose. Out on the grasslands, the travellers halt where fuel is to be had from tree-ferns or some timber patch, and wherever they stop they build a fire. These fires are left burning when the party moves on, and sometimes the grass is fired by hunters in pursuit of game. The absence of large quarry in this area would, however, argue against any great activity on the part of hunters in intentionally starting fires.

The peaty character of the soil on the highlands of the Snow Mountains and the weather experienced at Lake Habbema, where a camp was maintained for four months (July 20–November 18) in the south-east season or “dry monsoon,” point to the area being climatically wet. Forest fires probably occur only in exceptionally dry times. Then the long-grass community, from its proximity to the forests, where it attains its maximum development in the forest zone, must constitute a very definite fire hazard, against which the chief protection of the forests would lie in their border shrubberies, which, by retarding air movement and evaporation, would help to keep the bryophytes of the interior in a condition too moist to burn. Macgregor,¹ in describing a fire which

¹Annual Report, British N. Guinea 1889–1890: 43.

occurred at an altitude of about 3100 m. on the Owen Stanley Range and in a few minutes "swept like a tornado" over scores of acres of grassland, mentioned that "the surrounding forest growth, although it looked very dry, did not burn."

Since the natives frequently carry wood to some open spot and there light their fires, the presence of charcoal and fragments of charred wood on these much travelled grasslands is not a reliable indication of the former existence of forest in places where such traces of fire are found. Bits of charcoal and charred wood are seen in places distinctly unfavourable for the development of forest or the growth of trees. The distribution of trees within altitudes corresponding with the range of the conifers would appear to a very large extent controlled directly by local climate, and that of closed tree communities, that is, communities capable of carrying destructive fires, by edaphic conditions. *Libocedrus* forms open stands where the soil will not support any other kind of tree, where even shrubberies seem unable to develop, and where the long-grasses—the only grasses which will carry fire—yield control of the habitat to the dwarf species of the bog turf. But rarely will one find even a *Libocedrus* in any stage of growth, and never a mature tree, out in the broad hollows and valleys. Yet, on the well drained soil of the banks of streams in these cold hollows and valleys the long-grasses grow rankly in closed stands, and there, too, is found an abundance of tree-ferns. The long-grasses cover marshes and quaking bogs as well as the driest grassland soils. The primary habitats in which the tree-ferns thrive best are the long-grass community, as developed on good soil on the banks of streams and about forest edges on the ridges, and the forest border shrubberies. Their soil requirements apparently are very close to those of the closed tree communities. The destruction of forest by fire, by leaving open to invasion soils peculiarly suited to them, affords the tree-ferns an opportunity to extend their territory. They may occur in large numbers on denuded forest land. Above the conifer zone, except for some scattering among rocks, all but relic trees occur in closed communities which, as the severity of the climate increases with altitude, become proportionately more exacting as to soil conditions. At their upper limit imposed by climate, trees are to be found only on the warmest and driest soil in the most sheltered positions available.

Old specimens of *Podocarpus papuanus* Ridl., which seems better able to withstand fire than *Libocedrus* but is apparently unable to reproduce itself under grassland conditions, often occur as forest relics in long-grass adjacent to standing forest. In the absence of dead or relic

trees, abundant charcoal, and of course forest regenerative communities, tree-ferns when growing in numbers on ridges may be looked upon as possible indicators of deforestation by fire.

Much has been written regarding the difficulty high-mountain forest has in maintaining itself when in contact with grassland, and there are known instances of its disappearance from mountain tops as a result of fire. Lane-Poole¹ has mentioned extensive deforestation by hunter's fires on Mt. Sarawaket in Northeastern New Guinea, and figured burnt edges of *Dacrydium-Libocedrus* forest and tree-ferns growing on grass slopes rising from what would appear to be natural open hollows. The Archbold Expedition of 1933-34, of which the writer was a member, found the top of the Wharton Range largely deforested and covered with tussock grass (*Danthonia Archboldii* Hitchc.) and tree-ferns (*Cyathea Macgregori* F. v. M. and *C. gleichenioides* C. Chr.) from Murray Pass west to Mt. Albert Edward. At 3300 m. one great fire had, a few years before, completely destroyed the *Podocarpus-Libocedrus* forest over an area of several square miles. The tussock grass was establishing control in a burn community of annuals characterized by *Poa longiramea* Hitchc. and *Epilobium* sp., and although forest second growths were obviously at a disadvantage in competition with the grasses, young thickets of *Coprosma papuensis* were making good headway in parts. Of an estimated 50 sq. miles of grassland above 3500 m. on Mt. Albert Edward, probably only one-third could be considered a primary condition. This section of the central range appeared to have a much drier climate than the Snow Mountains. Wallabies and wild pigs were plentiful on the grasslands and extensively hunted by people living on both sides of the range. The forests of the broad crest of the range were well on the way to eventual extermination.

A different state of affairs obtained about Lake Habbema and on Mt. Wilhelmina. Such fires as had occurred there recently enough for their limits to be defined with certainty, by the presence of dead trees and by other means, had affected only small areas. The fires as a rule were not stopped by any natural barrier; they burned themselves out in forest. On some of these areas scattered or clumped shrubs and numerous tree-ferns grew in a dense cover of long grass that, perhaps after a succession of fires, had taken possession. Most of the burned forest areas carried, however, vigorous regenerative communities. In the conifer zone, succession was initiated by shrubs of the primary forest borders, such as *Drimys*, *Styphelia*, *Rhododendron* and *Coprosma* with, between them, *Tetramolopium* from the grasslands, *Selligoea Feei* on the ground, and sometimes *Rubus* and young tree-ferns. *Libocedrus*

¹Forest Resources of the Territories of Papua and New Guinea, 65, 66, 1925.

regenerated freely on formerly forested ground that had gone to grass, and in some instances shrubs pushing out from the edge of neighbouring forest were slowly re-establishing forest conditions. Above the conifer zone, the forest secondary communities were mainly of *Coprosma* spp., with which, up to about 3650 m., were associated a great many treeferns.

A general view of the area leaves the impression that the forests of Lake Habbema and Mt. Wilhelmina have succeeded in maintaining themselves very well over what must have been a long period of disturbance by the fires of native travellers. Forest in some form or other still occupies by far the greater part of the area assumed capable of supporting forest.

MAJOR PLANT COMMUNITIES

Several botanists with field experience in New Guinea, notably Lauterbach¹ for localities including the Sattelberg Mountains in North-eastern New Guinea and Gibbs² for the Arfak Mountains in Netherlands New Guinea, have given detailed accounts of the vegetation in which local altitudinal zonation received attention. Lam³ in 1934 published a preliminary floristic review and the first vegetation map of the island. Bohrer⁴ has recently produced for the Territory of Papua a very detailed vegetation map compiled from Government patrol reports and other literature, which, like that of Lam, necessarily leaves much to be desired from the point of view of accuracy, and must be regarded, as indeed both maps are advanced as, preliminary and approximate.

The first to attempt a classification of the major plant communities of New Guinea as a whole was the forester Lane-Poole,⁵ who, in his report on the forests of the two eastern Territories, distinguished the following "forest regions," defined by climate and altitude:—

Savannah forests

Lowland forests	0- 1,000 ft.	(0- 300 m.)
Foothill forests	1,000- 5,500 ft.	(300-1700 m.)
Mid-mountain forests	5,500- 7,500 ft.	(1700-2250 m.)
Mossy forests	7,500-11,000 ft.	(2250-3350 m.)
High-mountain forests	over 11,000 ft.	

¹Bot. Jahrb. 62: 284-304, 550-569. 1928; 63: 1-28, 419-476. 1929.

²A Contribution to the Phytogeography and Flora of the Arfak Mountains, London. 1917.

³Blumea 1: 115-159. 1934.

⁴"Papua" Physische Landeskunde von British Neuguinea, Frankfurt. 1939.

⁵l. c. p. 4 et seq.

Lane-Poole described the savanna-forests as "open forests, similar to the large areas that occur in Australia," consisting chiefly of *Eucalyptus* spp. His lowland forests are the mixed rain-forests. Of his foothill forests he writes (p. 33): "They lack character, and at times seem only a degenerated form of the rain forests of the lowlands; the same species keep cropping up, and the only difference is that the foothill rain forest is a pole wood, or at best an assembly of low, small-girthed trees. One has just decided that such is the case, and is beginning to ascribe reasons for the low quality of the rain forest, when patches of purely foothill species are met with, and the rain forest becomes quite dominated by what is certainly a different type of woodland." He considered *Quercus Junghuhnii* Miq. (*Castanopsis Junghuhnii* (Miq.) Mgf.) the most characteristic foothill tree, and stated that a marked overlap of other oaks and also *Araucaria* spp., from the mid-mountain forest, may occur. The mid-mountain forest is described (p. 35) as "climatically very well defined, so far as its lower limits are concerned, for it corresponds to the cloud belt," and is characterized by oaks of several species and *Araucaria Cunninghamii* Ait. *Podocarpus thevetiifolius* Zipp. and *Xanthomyrtus longicuspis* Diels are stated to form over 80 per cent. of the mossy-forest stocking on Mt. Obree. The high-mountain forests are described as forests of *Podocarpus*, *Dacrydium*, *Phyllocladus*, and a few non-coniferous trees.

Lane-Poole rejected as inapplicable the term "alpine" for the extensive grasslands seen by him on the upper parts of Mt. Sarawaket (4100 m.). "There is no doubt in my mind," he wrote (p. 180), "that, except for the very marshy land and the actual cliffs and outcrops of limestone, the whole of this mountain top was under a forest of conifers and myrtles," which had been denuded and burned to grass by the natives.

Van Steenis,¹ in the second part of his monumental work on the origin of the Malaysian mountain flora, has proposed the following altitudinal zones for the region, arrived at by the statistical analysis of collections of mountain plants: —

0-1000 m.	Tropical zone
500-1000 m.	Colline subzone
1000-2400 m.	Montane zone
1000-1500 m.	Submontane subzone

¹Bull. Jard. Bot. Btzg. III, 13: 289-417. 1935.

(Continued)

2400-4000 m.	Subalpine zone (up to tree limit)
4000-4500 m.	Alpine zone (tree limit to climatic snow line)
4500 m.-upwards	Nival zone

Elsewhere,¹ van Steenis advances the opinion that savannas are not a natural vegetation, but the result of continuous burning. His colline subzone would appear to correspond to the foothill forest zone of Lane-Poole.

Following is a summary of the major plant communities recognized by the Archbold Expedition of 1933-34, which worked in the semi-arid areas of Port Moresby and the Oriomo River, and from two lowland and six mountain camps on a cross section of the south slopes of the central range from Hall Sound to the summit of Mt. Albert Edward. In the Port Moresby area, savanna and savanna-forest, grassed with *Themeda triandra* Forsk. and timbered with *Eucalyptus* spp., extended from the coast to an altitude of at least 600 m. on the Astrolabe Range. Similar savanna grasslands occupied a large extent of country and reached an elevation of 130 m. behind a forested coastal fringe to the northeast of Hall Sound. The Oriomo River flowed through a vast area of savanna and savanna-forest, extending from the Fly River west into Netherlands territory, on which grasses of several genera dominated the ground cover, species of *Tristania* and *Melaleuca* were the principal trees, and *Eucalyptus* also occurred. In contact with savanna on dry coastal hills about Port Moresby, and also behind Hall Sound, was a forest characterized by deciduous trees such as *Gyrocarpus americanus* Jacq. and *Bombax malabaricum* L., to which the term monsoon-forest should perhaps be applied. Mixed rain-forest occurred in isolated patches and in strips along streams in the semi-arid areas and replaced the savanna vegetation of the Port Moresby and Hall Sound districts as rainfall increased inland. This forest, the greatest of all in respect of area in New Guinea, covered the climatically wet lowlands and foothills and pushed up the mountain valleys and ravines to elevations of 2400 m. on Mt. Tafa Range and 1800 m. or more on the Wharton Range. Next above the rain-forest in altitudinal sequence was a less mixed forest, at first nearly a pure stand of *Castanopsis Junghuhnii* (Miq.) Mgf., very open under the canopy, with above it a second association dominated by oaks and containing quantities of *Engelhardtia*

¹Bull. Jard. Bot. Btzg. III. 14: 50-55. 1936.

sp. *Araucaria Cunninghamii* Ait. was common, sometimes plentiful, above about 1200 m. This fagaceous forest first appeared at 480 m. on the outer spurs of the mountains. In the Vanapa Valley, under the lofty Wharton Range, it had occupied originally a broad band between altitudes of about 1500 m. and 2000 m. on south-facing slopes, and occurred in patches up to 2350 m. on north-facing slopes. In the Vanapa Valley, and also the valley of the Auga River, this and the upper rain-forest had largely disappeared and been converted to grass by big native populations. Above the main body of the oak-*Castanopsis* forest on the Wharton Range, and especially on the north face of Mt. Tafa Range or the south side of the Vanapa Valley, was a very tall forest dominated by *Nothofagus* sp., which was examined between levels of 2100 m. and 2300 m. and probably extended higher and lower on the slopes. Forests of *Xanthomyrtus* spp. and *Phyllocladus pro-practus* Pilg., stunted and very mossy on exposed crests, elsewhere tall and not heavily mossed, clothed the upper slopes and the summit of Mt. Tafa Range (2800 m.) and followed its southern spurs down to 1500 m., and on the Wharton Range extended from about 2400 m. on south-facing slopes up to 3200 m. on its crest. From 3200 m. on the Wharton Range up to tree limit at 3850 m. on Mt. Albert Edward, and appearing as low as 3000 m. on wet ground, were forests at first dominated by *Podocarpus papuanus* Ridl. and *Libocedrus papuana* F. v. M., and at higher altitudes by *Vaccinium* sp. with the conifers rising in an open stand above the canopy. Grasslands populated by alpine species were first met with at 2750 m. on deforested parts of the Wharton Range, and there were natural glades in *Xanthomyrtus-Phyllocladus* forest as low as 2900 m. The subalpine forest of conifers and *Vaccinium* had always been considerably interrupted by grassy glades, hollows and lake basins, and probably one-third of the extensive open highlands between the 3500 m. level and the 3980 m. summit of Mt. Albert Edward were under a primary cover of grasses.

The above interpretation of major communities shows several points of difference from that of Lane-Poole. In the first place, there is the monsoon-forest, which Lane-Poole described (l. c. p. 5) and considered intermediate between rain-forest and savanna-forest. Secondly, since the foothill forest described by Lane-Poole appears to comprise parts of the upper rain-forest and what should best be considered the lower part of his mid-mountain forest, it has not been possible to distinguish it as a distinct unit. Thirdly, although now known from localities 900 km. apart and probably distributed over all the island, hitherto the *Nothofagus*-forests have gone unrecognized, and this is the first report

of their existence in New Guinea. Finally, the alpine grasslands encountered by the Archbold Expedition of 1933-34 are considered, in part, primary, and an expression of the climate.

On the other hand, all but three of the major plant communities encountered by the Archbold Expedition of 1933-34, viz. savanna, monsoon-forest and *Xanthomyrtus-Phyllocladus* "mossy forest," have their counterpart in the Netherlands New Guinea territory examined by the 1938-39 expedition, and are described in this paper. The wet low-land climate is sufficient explanation for the absence from this area of savanna and monsoon-forest, such as is found in semi-arid parts of New Guinea. There is no such convenient circumstance to explain the absence of the third community, which is doubtless the "mossy forest" of Lane-Poole. The generic dominants, it is true, occur commonly as subsidiary trees or as minor dominants in the *Nothofagus*-forest as found in Netherlands territory, and they enter the subalpine forest of the Snow Mountains, but there the *Xanthomyrtus-Phyllocladus* forest can not be distinguished as a distinct community.

Only two well marked climatic types of vegetation occurred in the area visited by the Archbold Expedition of 1936-37, namely, rain-forest and savanna.

The observations of the writer in both east and west New Guinea suggest some modification and emendation of the classification of major plant communities proposed by the pioneer investigator Lane-Poole. These suggestions are advanced without any pretence to an understanding of the ecological factors responsible for the differentiation of most of what are believed to be well defined and, if the statement may be risked, climatic plant formations. Lane-Poole stressed the lower limit of the daily cloud accumulation on the mountains as defining the lower bounds of his mid-mountain forest. The writer, in 1933-34, noted that the lower edge of the afternoon cloud banks, which formed between 2 p.m. and 5 p.m., marked almost exactly, in an oblique line ascending with the mountains, the lower limits of this same forest if taken to include the forest characterized by *Castanopsis*. Also, the *Xanthomyrtus-Phyllocladus* mossy-forest was observed to be generally under cloud by 10 a.m. or noon. Yet, on the mountains rising from the Meervlakte, in Netherlands New Guinea, the *Nothofagus*-forest descended just to the lower edge of the clouds that formed about the middle of the forenoon, and this also seemed to hold good in the valley of the Balim. In east New Guinea, the writer found the line of demarcation between rain-forest and mid-mountain forest to coincide with an abrupt change from greyish and often rather rubbly soil to a deep reddish soil, but this was seldom the case in Netherlands New Guinea.

Since actual levels are likely to be of more practical use to the field botanist and the plant geographer than average levels, the elevations between which the communities have been observed in control are given in the following table. The upper limit of 1700 m. for savanna vegetation is from an observation by Lane-Poole:—

Savanna and savanna-forest	0-1700 m.
Monsoon-forest	0- 450 m.
Rain-forest	0-2400 m.
Mid-mountain forest	480-2350 m.
Beech-forest	850-3100 m.
Mossy-forest	1500-3200 m.
Subalpine forest	3000-4050 m.
Alpine grassland	2900 m. up to permanent snow line

To a large extent the species and in some cases even the genera of the dominant and characteristic constituents of the various communities as represented in the collections of the Archbold Expeditions are taxonomically undetermined. From these collections it is, however, possible briefly to define the communities as to dominants.

Savanna and Savanna-forest: The savannas and savanna-forests of the semi-arid areas differ only in tree spacing. The grasses and trees are the same, and the former are here regarded as the community dominants. The essential characters persist through wide variations in type due to local edaphic and zonal and regional climatic conditions. A treeless condition may generally be explained by an excess of ground water in the wet season. The savannas occupy about 3 to 4 per cent. of the area of New Guinea. They occur under a climate marked by pronounced wet and dry seasons, with a low to rather high annual rainfall of less than 1000 mm. to over 2300 mm. The deforested valleys at elevations of about 1000-2500 m. in the mountains are occupied by grasses of this community. Grasses: *Themeda*, *Ischaemum*, *Manisuris*, *Ophiurus*, *Imperata*, *Germainia*, *Heteropogon*, *Pollinia*. Trees: *Eucalyptus*, *Melaleuca*, *Tristania*, *Acacia*, *Banksia*, *Grevillea*, *Casuarina*, *Parinarium*, *Albizzia*, *Petalostigma*. Small areas of palm (*Livistona*) and *Pandanus* savanna occur to the west of the Fly River. According to Lane-Poole, *Eucalyptus* is absent from the apparently natural savannas of the northeast coast.

Monsoon-forest: Developed in the semi-arid areas and of limited extent. Dominants deciduous or evergreen, undergrowth chiefly woody and more or less sclerophyllous. Chief dominants: *Gyrocarpus*, *Bombax*, *Aleurites*, *Cochlospermum*, *Alstonia*, *Lagerstroemia*, *Albizzia*, *Semecarpus*. Undergrowth: *Flueggea*, *Harrisonia*, *Ehretia*, *Murraya*. A bamboo substage is sometimes developed in this and the drier rain-forests.

Rain-forest: Developed chiefly on the humid lowlands and lower mountains, these well known forests thrust outliers far up the cool mountain valleys, occur in the semi-arid areas in edaphically favourable situations such as the banks of streams, and supply probably 70 to 80 per cent of the vegetation cover of the island. Owing to the varied conditions under which they occur, they are very diversified in character, and not necessarily very mixed as regards dominants, or structurally complex, or rich in woody and herbaceous undergrowth, lianes and epiphytes. Important climax dominants include species of *Syzygium*, *Elaeocarpus*, *Terminalia*, *Intsia*, *Pterocarpus*, *Octomeles*, *Sloanea*, *Canarium*, *Myristica*, *Calophyllum*, *Garcinia*, *Dysoxylum*, *Pometia*, *Dracontomelum*, *Wormia* and *Dipterocarpaceae*. Subseral dominants: species of *Macaranga*, *Homalanthus*, *Saurauia*, *Ficus*, *Callicarpa*, *Glochidion*, *Trema*, etc., which seldom if ever occur in climax forest.

Mid-mountain forest: Best developed on smooth slopes in broad valleys, this forest is characterized by the high degree of dominance attained by few species. In its most distinctive form it is rather low in stature, dry-appearing, open under the canopy, deficient in undergrowth, and with few lianes or epiphytes; or it may be tall, moist, and not readily distinguished from some types of rain-forest. The largest native populations in the interior of New Guinea are centered in this forest zone, and little of the forest survives in the heavily populated valleys. Climax dominants: *Quercus* sens. lat., *Castanopsis* and *Engelhardtia*. *Araucaria Cunninghamii* Ait. occurs, often in great numbers, as an outstanding tree upwards of 50 m. high, or twice the height of the dominants. Subseral dominants, none of which occur in climax forest, include *Vaccinium* spp., *Grevillea subargentea* C. T. White, *Casuarina* and *Albizzia*, and *Cyathea contaminans* (Wall.) Copel. is a characteristic tree-fern.

Beech-forest: Usually a practically pure forest of *Nothofagus* spp., up to 40 m. high on sheltered slopes, and on exposed spurs reduced to scrubs. A forest with a generally rich and conspicuous bryophyte flora in which hepatics predominate, and very heavily "mossed" on both trees

and ground when of stunted growth. Native populations have considerably disturbed the lower parts of this forest, but cultivation and deforestation come to an end with the development of a peaty top soil at higher levels. In potential commercial value, the beech-forests probably exceed all others in New Guinea as a source of durable hardwoods. Subseral dominants, most of them derived from the lower layers of the primary forest, include species of *Rapanea*, *Quintinia*, *Drimys*, *Eurya* and *Kania*.

Mossy-forest: Like the beech-forests, which appear to have replaced them in the area examined in the Snow Mountains, the mossy-forests may be tall and not conspicuously mossed, or in exposed positions stunted to the form of heavily mossed scrubs. The "mosses" are chiefly hepatics. A dense, impenetrable undergrowth of scrambling bamboo is often present. Chief climax dominants: *Xanthomyrtus*, *Phyllocladus* and, according to Lane-Poole, *Podocarpus thevetiifolius* Zipp. Subseral dominants on Mt. Tafa and the Wharton Range include *Olearia*, *Rhododendron*, *Rapanea*, *Elaeocarpus*, *Archboldiodendron*, *Alphitonia* and *Homalanthus*, derived in part from the primary forest.

Subalpine forest: A forest dominated at its lower levels by *Podocarpus papuanus* Ridl., *Libocedrus* and, according to Lane-Poole, *Dacrydium* sp. *Vaccinium* spp., which characterize a subsidiary layer of low trees at the lower elevations, attain general dominance as the conifers thin out and finally disappear with altitude. A rich and abundant flora of bryophytes is characterized by hepatics in the conifer zone and by mosses in the *Vaccinium* zone. Subseral dominants: *Coprosma*, *Drimys*, *Styphelia*, *Rhododendron* and *Cyathea*, chiefly derived from the shrubberies that border the primary forest where it touches on the alpine grassland.

Alpine grassland: As in the case of the savanna grasslands of low altitudes, with which they have not a single species and but few genera in common, the alpine grasslands are developed under a rigorous climate, and edaphic conditions are important in determining their relationships with the contiguous forests. Dominants: chiefly *Monostachya*, *Aulacolepis*, *Deschampsia*, *Danthonia* and Cyperaceae. Other characteristics include *Potentilla*, *Ranunculus*, *Eriocaulon*, *Plantago*, *Astelia*, *Centrolepis*, *Epilobium*, *Gentiana*, *Ischnea* and *Euphrasia* as herbs, *Tetramolopium*, *Hebe*, *Rhododendron*, *Styphelia*, *Vaccinium*, *Eurya* and *Kelleria* as shrubs, and peculiar species of *Cyathea* as tree-ferns.

EXPLANATION OF PLATES

PLATE I

- FIG. 1. Aerial photograph of the crest of the Snow Mountains, looking west over Mt. Wilhelmina towards Mt. Carstensz from a position above the 3800 m. Camp (X) of the expedition. Behind the camp is Scree Valley, with a small lake at its head, the limestone summit ridge to the south, and the sandstone false peak to the north.
- FIG. 2. Aerial photograph of the Grand Valley of the Balim River, from a position near the meeting place of the Teerink and van Arcken patrols. Most of the tree growths are secondary forests of *Casuarina*. The approximate position of the expedition's 1600 m. Camp marked X.

PLATE II

- FIG. 1. Strips and patches of *Vaccinium-Rapanea* subalpine forest at 3800-3900 m. on the north slope of Mt. Wilhelmina. *Coprosma* 9939 grows among tussocks of *Deschampsia Klossii* Ridl. in the foreground. In the background is the eastern termination of the summit ridge, and in the lower left the 3800 m. Camp.
- FIG. 2. Interior of the strip of *Vaccinium-Rapanea* forest shown in the right foreground of Fig. 1. Mosses, hepatics and *Meringium Forsteri* (Ros.) Copel. cover trees and ground. *Sclliguea Feei* Bory appears in the ground moss on right, and *Styphelia nubicola* Wernh. forms the inner part of the border shrubbery on left.

PLATE III

- FIG. 1. Mt. Wilhelmina viewed over the expedition camp on Lake Habbema from an altitude of 3265 m. on the rim ridge of the Grand Valley. *Podocarpus papuanus* Ridl. and *Libocedrus* sp. protrude above a patch of closed *Vaccinium* forest in the foreground. The ridges about the lake carry an open stand of *Libocedrus* growing in *Rhododendron* shrubberies and low-tree thickets.
- FIG. 2. A grassy hollow, and ridges covered with closed subalpine forest of *Vaccinium*, *Podocarpus* and *Libocedrus*, at an elevation of 3230-3250 m. on the north side of Lake Habbema. The tree-fern *Cyathea tomentosissima* Copel. lines the banks of an entrenched stream, and between the stream and the forest is a patch of newly burnt grass.

PLATE IV

- FIG. 1. View over the Bele River valley from an altitude of 2350 m. on the slope opposite the 2200 m. Camp. *Nothofagus* forests cover both slopes, and *Engelhardtia* sp. and two species of oaks grow on

the edge of the clearing in the foreground. *Imperata* grasslands and forest secondary communities surround the native hamlets and gardens.

- FIG. 2. View north over the Grand Valley of the Balim, from a position just below the 1600 m. Camp. Stone garden walls pattern the valley floor and the deforested limestone range rising to about 2400 m. across the river. The tree growths consist of mixed secondary communities in the foreground, a relic gallery strip of primary *Castanopsis* forest at the foot of the foreground slope, and *Casuarinas* on the valley bottom.

PLATE V

- FIG. 1. Typical tall forest of *Nothofagus 11115* at 2450 m. in the Bele River valley. Most of the undergrowth and the smaller trees have been removed by the natives as a preliminary to felling the forest.
- FIG. 2. "Mossy" low forest of *Nothofagus 13147* at an elevation of 900 m., 4 km. southwest of Bernhard Camp. *Pandanus leptocaulis* Merr. & Perry appears in the undergrowth. Hepatics form most of the thick bryophyte cover on trees and ground.

PLATE VI

- FIG. 1. Expedition camp in flood plain rain-forest at 850 m. on Araucaria Creek, 4 km. southwest of Bernhard Camp.
- FIG. 2. View northeast over the Meervlakte and the Idenburg River from the 2150 m. Camp of the expedition.

(Photographs by Archbold Expeditions)

PLATE VII

Map of the area visited by the Indisch-Amerikaansche Expeditie to Netherlands New Guinea, showing land routes, camps, and the route followed on aerial transport flights.

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NEW YORK.

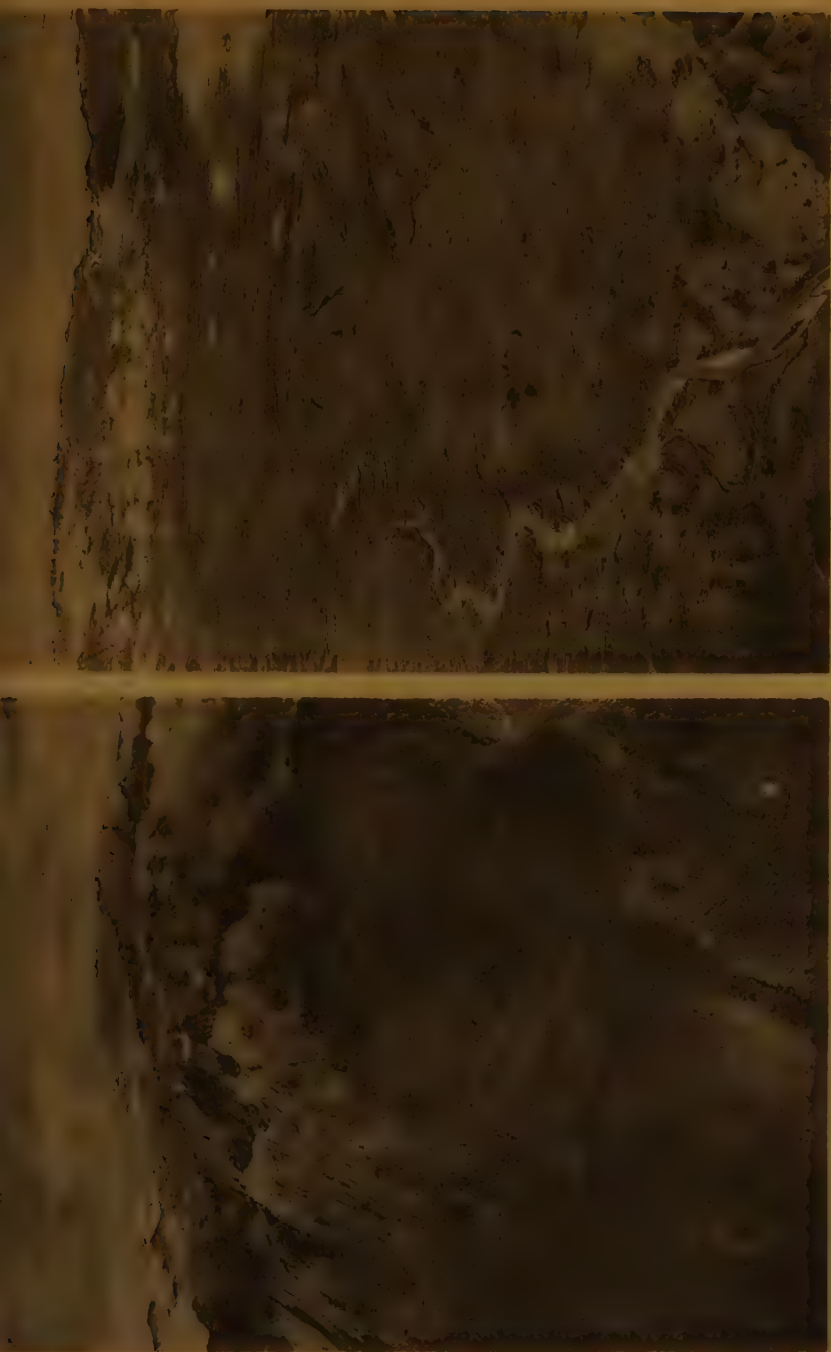


FIGURE 1

FIGURE 2

[Transposed]

THE 1938-39 EXPEDITION TO THE SNOW MOUNTAINS, NETHERLANDS NEW GUINEA



FIGURE 1



FIGURE 2

THE 1938-39 EXPEDITION TO THE SNOW MOUNTAINS,
NETHERLANDS NEW GUINEA



FIGURE 1



FIGURE 2

THE 1938-39 EXPEDITION TO THE SNOW MOUNTAINS,
NETHERLANDS NEW GUINEA



FIGURE 1

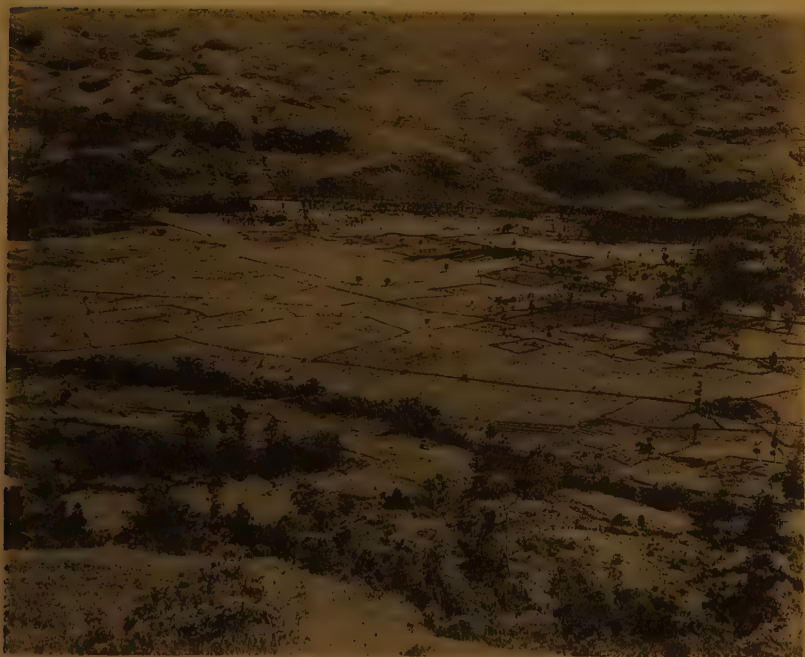


FIGURE 2

THE 1938-39 EXPEDITION TO THE SNOW MOUNTAINS,
NETHERLANDS NEW GUINEA



FIGURE 2



FIGURE 1

THE 1938-39 EXPEDITION TO THE SNOW MOUNTAINS, NETHERLANDS NEW GUINEA



FIGURE 1

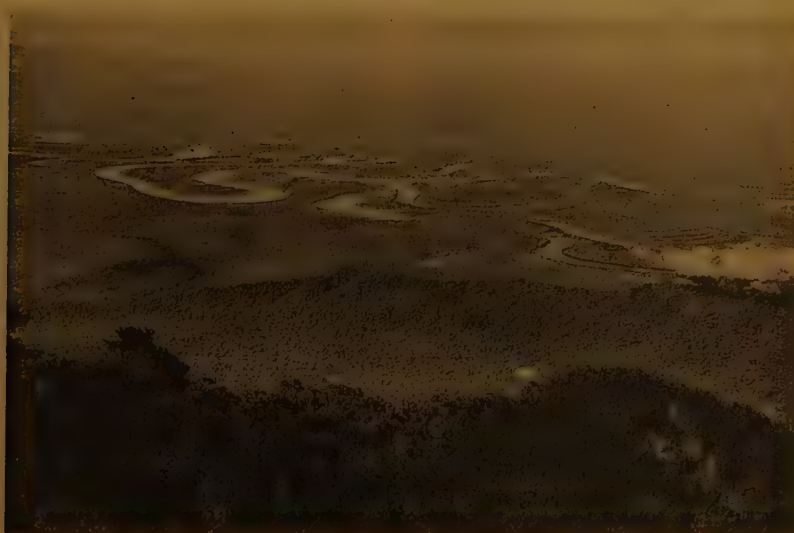
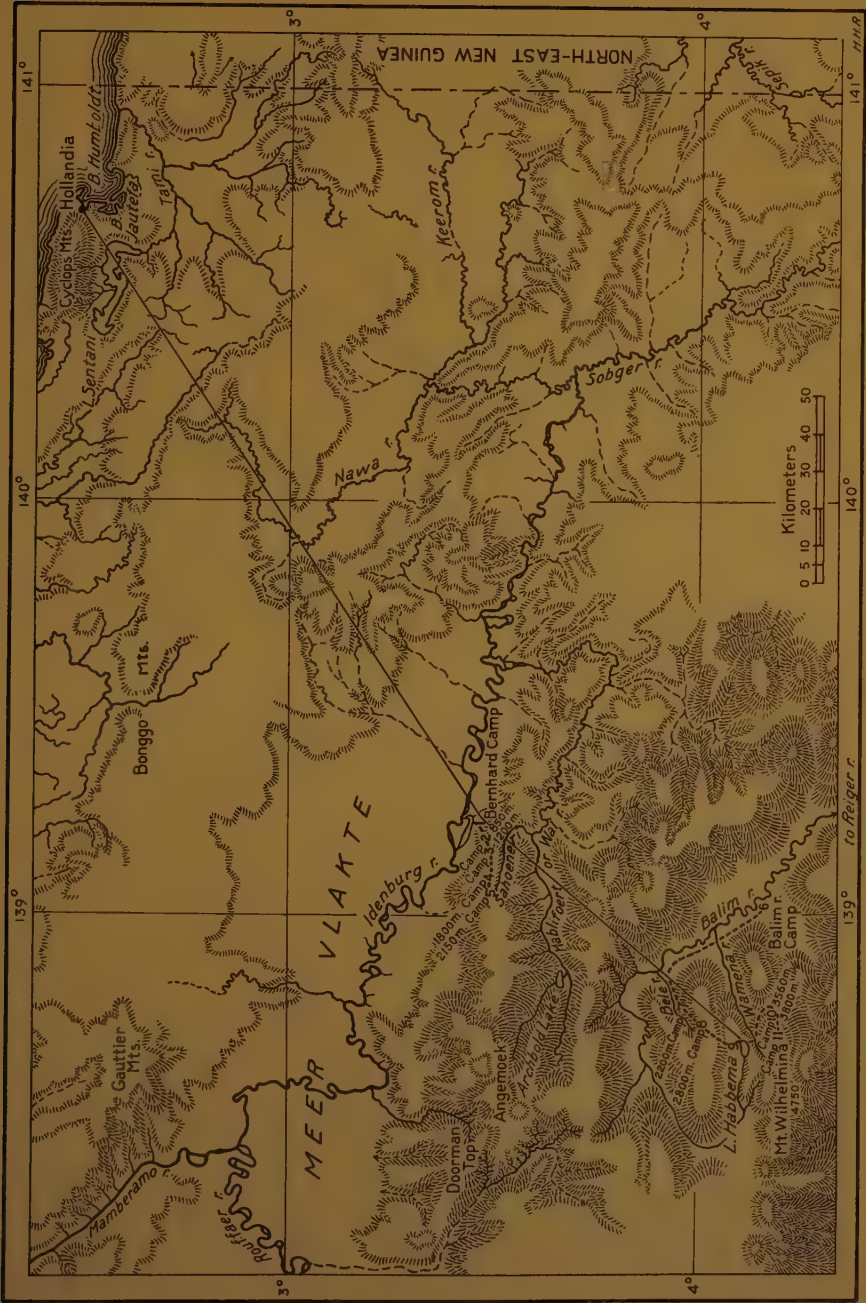


FIGURE 2

THE 1938-39 EXPEDITION TO THE SNOW MOUNTAINS,
NETHERLANDS NEW GUINEA



THE 1938 - 39 EXPEDITION TO THE SNOW MOUNTAINS, NETHERLANDS NEW GUINEA

STUDIES OF PAPUASIAN PLANTS, III*

A. C. SMITH

GUTTIFERAE

THE most essential treatments of Guttiferae, for a study of the Papuan species, are those of Vesque (in DC. Monogr. Phan. 8: 1-669. 1893), Lauterbach (Bot. Jahrb. 58: 1-49. fig. 1-10. 1922), and Engler (in Engl. & Prantl, Nat. Pfl. ed. 2. 21: 154-237. fig. 68-107. 1925). In the present paper, only the new or otherwise noteworthy species of recent collections are discussed; the order of genera and sections proposed by Engler is followed. My work has been facilitated by the examination of specimens in the following herbaria: Arnold Arboretum (A), New York Botanical Garden (NY), Yale School of Forestry (Y); the place of deposit is shown by the parenthetical letters, in the absence of which the specimen is to be found only in the herbarium of the Arnold Arboretum.

HYPERICUM L.

Hypericum (§ *Brathys*) **habbemense** sp. nov.

Frutex glaber gracilis ramosus ad 2 m. altus, ramulis gracilibus subteretibus fuscis vel purpurascens, novellis leviter complanatis vel obscure quadrangulatis; foliis oppositis, laminis sessilibus subamplexicaulibus papyraceis ovato-ellipticis, (9-)12-23 mm. longis, (4-)7-17 mm. latis, basi rotundatis, apice rotundatis vel obtusis, margine integris vel obscure undulatis, copiose glandulis utrinque paullo prominulis pellucido-punctatis, siccitate fusco-olivaceis vel subtus pallidioribus, 7-11-nervatis, nervis adscendentibus utrinque prominulis vel supra subplanis rete venularum inconspicuo obscure conjunctis; floribus nunc terminalibus et solitariis nunc in cymas plus minusve foliatis aggregatis sub anthesi 23-25 mm. diametro; pedicellis gracilibus ad 15 mm. longis apicem versus gradatim incrassatis; sepalis 5 persistentibus papyraceis lanceolato-ellipticis, 4-5 mm. longis, 1.5-2.2 mm. latis, longitudinaliter pellucido-glanduloso-lineolatis, apice obtusis, marginem versus parce pellucido-punctatis, margine interdum nigro-glanduloso-callosis; petalis 5 patentibus membranaceis obovato-ellipticis, 11-13 mm. longis, 6-8 mm.

*(Botanical Results of the Richard Archbold Expeditions) See Jour. Arnold Arb. 22: 60-80. 1941; op. cit. 231-252.

latis, flabellatim 12–15-nervatis (nervis saepe furcatis), basi conspicue angustatis, apice rotundatis, margine integris et saepe parce glandulosis; staminibus 25–30 liberis, filamentis gracilibus 5–7 mm. longis, antheris ellipsoideis circiter 0.6 mm. longis; ovario ovoideo-ellipsoideo sub anthesi circiter 3.5 mm. longo et 2.5 mm. lato uniloculari, basi rotundato, placentis 3–5 parietalibus circiter 0.3 mm. latis, stylis 3–5 (raro 6) gracilibus 2–2.5 mm. longis, stigmatibus subtruncatis; capsulis stylis exceptis circiter 6 mm. longis polyspermis, apice stylis persistentibus coronatis, 3(–5)-valvis, seminibus complanatis ellipticis utrinque rotundatis 0.3–0.4 mm. longis.

NETHERLANDS NEW GUINEA: 9 km. northeast of Lake Habbema, alt. 2600–2650 m., *Brass* 10865 (TYPE), Oct. 1938 (slender erect shrub up to 2 m. high, plentiful on open landslips in forest), *Brass* 10979 (sparsely branched shrub 0.5–2 m. high, plentiful on open landslips in forest of lower slopes; flowers yellow, showy); Bele River, 18 km. northeast of Lake Habbema, alt. 2200 m., *Brass* 11361 (slender shrub about 1 m. high, plentiful on open grassy banks of river; flowers yellow); southern slopes of Grand Valley (Lake Habbema region), alt. 1800–2000 m., *Brass* (coll. *Teerink*) 9261 (flowers yellow).

Hypericum habbemense is very distinct among species of the region, characterized by its fairly tall shrubby habit, its comparatively large, rounded, and conspicuously pellucid-punctate leaf-blades, its very large flowers, numerous stamens, and the variability in the number of its styles and placentas. While the styles appear to be most often three in number, four and five are common, and six are occasionally seen, but in this latter case I have not observed more than five placentas.

I have not seen material of *H. Hellwigii* Lauterb., but according to the description, *H. habbemense* is probably allied, differing in the characters mentioned above. *Hypericum papuanum* Ridley is described as an herb with smaller leaves and flowers than the new species, but nevertheless it seems possible that Ridley's species was based on a depauperate specimen and is actually the same as *H. habbemense*. As the description of *H. papuanum* is entirely inadequate, I venture to describe our plant as new, but a comparison of the types should eventually be made.

CALOPHYLLUM L.

Calophyllum (§ *Apoterium*) **procerum** sp. nov.

Arbor grandis ubique praeter partes novellas et bracteas inflorescentiarum ferrugineo- vel cinereo-puberulas vel tomentellas glabra, ramulis novellis angulatis mox teretibus et cinereis; petiolis 7–13 mm. longis

canaliculatis superne complanatis; laminis coriaceis oblongo-ellipticis, 4–7 cm. longis, 2–4 cm. latis, basi acutis et in petiolum decurrentibus, apice rotundatis vel obtusis, margine paullo incrassatis, costa valida supra conspicue canaliculata subtus prominente, nervis lateralibus numerosissimis (24–32 per centimetrum) patentibus utrinque leviter prominulis; inflorescentiis juvenilibus (solis visis) compactis minutis in ramulis inter folia orientibus vel interdum axillaribus; bracteis basi inflorescentiae 4 submembranaceis vel papyraceis elliptico-oblongis, 2.5–3 mm. longis, circiter 1.5 mm. latis, apice rotundatis, extus minute tomentellis; floribus 4 vel 5 per inflorescentiam pseudofasciculatis (minute racemosis, rhachi brevissima) bracteolis minutis glabris subtentis; sepalis 4, 2 exterioribus papyraceis suborbicularibus concavis in specimine nostro immaturis circiter 1 mm. longis et latis, 2 interioribus similibus sed submembranaceis; petalis ut videtur nullis; staminibus numerosis (80–100), filamentis immaturis brevissimis, antheris oblongis obtusis; ovario minuto glabro.

BRITISH NEW GUINEA: Western Division, Lake Daviumbu, Middle Fly River, *Brass* 7589 (TYPE), Aug. 1936 (large tree with rounded leafy crown, forming, with a few other species, a scattered super-canopy layer in rain-forest; trunk cylindric, the bark gray, hard, deeply fissured, about 3 cm. thick on old trees; sap yellowish; the natives use this tree for their larger dugout canoes).

Although the inflorescences of the cited specimen are immature, it is apparent that even at maturity they would be unusually small, compact, and few-flowered. The position of the inflorescences, which are usually scattered along the branchlets rather than axillary, is also remarkable. *Calophyllum procerum* is a relative of *C. Versteegii* Lauterb., from which it differs in its longer petioles as well as in the size and position of the inflorescences as above mentioned.

Calophyllum (§ *Apoterium*) **Warburgii** Engl. in Engl. & Prantl, Nat. Pfl. III. 6: 222. 1893; Lauterb. Nova Guin. Bot. 8: 843. 1912; Lauterb. Bot. Jahrb. 58: 13. 1922.

Calophyllum lanceolatum Warb. Bot. Jahrb. 13: 381. 1891; non Bl. (1825), non Teijsm. & Binn. (1855).

BRITISH NEW GUINEA: Western Division, Lake Daviumbu, Middle Fly River, *Brass* 7698 (common tree in rain-forest canopy, the bark hard, suberose, fissured, with yellow latex; flowers white), *Brass* 7724 (shapely tree 8–10 m. high, common in second growth rain-forest on old garden sites, the bark rusty brown, slightly flaky and with scattered very large lenticels; sap yellow, viscid; flowers white, fragrant), *Brass*

7745 (common tree of rain-forest canopy layer, the dark brown, thick, lenticellate, marked with shallow longitudinal fissures; sap cream-colored; flowers white, the filaments very slender), *Brass* 7748 (better flowering material of 7745).

The species has previously been reported only from the Key Islands and southern Netherlands New Guinea. Among the cited specimens, 7698 is an excellent match with *Warburg* 20048 (type coll.); the other specimens have a tendency toward slightly broader leaves, more ample inflorescences, and larger sepals, but these characters hardly seem of nomenclatural value.

Also of this relationship is *Brass* 7385 (BRITISH NEW GUINEA: Palmer River, 2 miles below junction with Black River, alt. 100 m.; canopy tree, common on the lower ridges). This specimen, in fruit, has leaves similar to those of the type collection of *C. Warburgii* but with the lateral nerves slightly more spaced. The fruiting inflorescences are racemose, up to 6.5 cm. long, and the apparently mature fruits are subglobose and about 14 mm. in diameter. Additional collections are desirable in order to ascertain the range of variation of *C. Warburgii*.

Calophyllum (§ *Apoterium*) *trachycaule* Lauterb. Bot. Jahrb. 58: 13. fig. 3. 1922.

BRITISH NEW GUINEA: Central Division, Kubuna, alt. 100 m., *Brass* 5654 (A, NY) (densely foliaged symmetrical tree 10 m. high, in rain-forest on low ridges, the bark pale brown, somewhat scaly; fruit dull blue).

The cited specimen agrees very well with the description and illustration of *C. trachycaule*, previously known from Northeastern New Guinea. Our specimen has the leaf-blades slightly larger (to 15 cm. long and 5 cm. broad) than those described and the fruits also somewhat larger (to 25 mm. long and 22 mm. broad), but these differences appear of little consequence.

Calophyllum (§ *Inophyllum*?) *solomonense* sp. nov.

Arbor grandis, ramulis juventute leviter angulatis (et gemmis) ferrugineo-puberulis vel -strigillosis mox subteretibus et fusco-cinereis; petiolis decidue puberulis rugosis crassis 15–23 mm. longis; laminis coriaceis subnitidis elliptico-oblongis, 11–23 cm. longis, 5.5–10 cm. latis, basi obtusis vel acutis et in petiolum decurrentibus, apice ut videtur obtusis vel rotundatis, margine incrassatis et leviter recurvatis, supra glabris, subtus praeter costam decidue ferrugineo-tomentellam glabris, costa valida supra valde elevata et inferne canaliculata subtus prominente et carinata, nervis lateralibus numerosis (18–26 per centimetrum) patenti-

bus leviter curvatis utrinque paullo prominulis; inflorescentiis sub fructu axillaribus racemosis (vel ut videtur interdum pseudofasciculatis) fructibus inclusis ad 4 cm. longis, pedunculo brevi et rhachi ad 12 mm. longis cum pedicellis 14–17 mm. longis rugosis et glabris, fructibus 1–3 per inflorescentiam ovoideo-subglobosis maturitate ad 22 mm. diametro, apice obtusis et stylo saepe coronatis, pericarpio 1.5–3 mm. crasso extra levi vel demum rugoso.

SOLOMON ISLANDS: *G u a d a l c a n a l*: Ma-massa, Konga, alt. 500 m., *Kajewski 2469* (TYPE), Feb. 8, 1931 (large tree up to 25 m. high, common in rain-forest, sometimes found on creek-banks and overhanging streams, the bark furrowed; native name: *coi-low*; an excellent timber-tree). *Y s a b e l*: Tataba, alt. 50 m., *Brass 3447* (common tree on rain-forest ridges, attaining large size, the bark rough, brown, scaly, the wood brown, tough; sap yellow, very viscid; branchlets, petioles, mid-ribs, and leaf-margins brown; fruits mottled-green).

Calophyllum solomonense cannot definitely be referred to a section in the absence of flowers, but it bears a close resemblance to *C. inophyllum* L. in foliage, differing obviously in its greatly contracted inflorescences. In the Brass specimen the fruits appear to be solitary in the leaf-axils; in the type this is rarely the case, the fruits being arranged on very short racemes. The fruits of the Brass specimen are apparently essentially mature, in which condition they are much smaller than those of *C. inophyllum*. *Calophyllum vitiense* Turrill and *C. samoense* Christophersen are also of the relationship of *C. solomonense*, but both have slightly narrower leaf-blades, more ample inflorescences, and probably larger fruits. To the best of my knowledge, only the ubiquitous sea-coast *C. inophyllum* has thus far been reported in the genus from the Solomons.

***Calophyllum* (§ *Inophyllum*) *vitiense* Turrill, Jour. Linn. Soc. Bot. 43: 17. 1915.**

SOLOMON ISLANDS: *B o u g a i n v i l l e*: Koniguru, Buin, alt. 850 m., *Kajewski 2020* (tree to 35 m. high, common in rain-forest; fruit yellow when ripe, to 38 mm. long and 25 mm. broad; native name: *pugiaro*; a good timber-tree). *G u a d a l c a n a l*: Ma-massa, Konga, alt. 400 m., *Kajewski 2463* (tree to 40 m. high, common in rain-forest, with medium-sized flanges and a rough furrowed bark; fruit black when ripe, to 30 mm. long and 22 mm. broad; tree furnishing an exceptionally fine cabinet wood); Uulolo, Tutuve Mt., alt. 1200 m., *Kajewski 2657* (tree to 30 m. high, common in rain-forest, the bark rough, furrowed; fruit purple when ripe, to 26 mm. long and 22 mm. broad; tree furnishing a fine cabinet wood).

The cited specimens are all in fruit, in which condition they agree in every respect with *Seemann 47* (cotype coll.) and several other Fijian specimens of *C. vitiense*. If my determination is correct, the species is to be anticipated in the New Hebrides. From Kajewski's notes, it seems that the tree is fairly common at middle elevation in the Solomons and is conspicuous by its great size.

Calophyllum (§ *Inophyllum*) **papuanum** Lauterb. Bot. Jahrb. 58: 9. 1922.

NETHERLANDS NEW GUINEA: 4–6 km. southwest of Bernhard Camp, Idenburg River, alt. 850–1200 m., *Brass & Versteegh 13124* (occasional tree of primary forest in flood-plain, 23 m. high, the trunk 30 cm. diam., the crown small; bark 4 mm. thick, brownish black, with some dark yellow sap; sap-wood brown; heart-wood reddish brown; fruits green), *Brass & Versteegh 12518* (frequent tree of primary forest on the slope of a ridge, 34 m. high, the trunk 45 cm. diam., the crown fairly small; bark 10 mm. thick, dark brown, with yellow resin; wood red-brown; fruits green), *Brass 12786* (canopy tree in rain-forest, 25 m. high, the trunk 35 cm. diam.; lower surfaces of leaves brown-pubescent). NORTH-EASTERN NEW GUINEA: Morobe District, Sattelberg, alt. 750 m. *Clemens 2278* (tree about 15 m. tall, on forest hill; fruits green); Yunzaing, alt. 1400 m., *Clemens 3656* (tree 30 m. high, in high forest, the trunk about 1 m. diam.; fruit green); Ogeramnang, alt. 1850 m., *Clemens 5389*.

Although the cited specimens bear fruit and leaves only, they can be referred to *C. papuanum* with some confidence; they agree with the description in all respects, including the persistently tomentellous or conspicuously puberulent aspect of the distal branchlets and the lower surface of the costa. Our specimens occasionally have the leaf-blades up to 10 cm. long and 5 cm. broad, slightly larger than those described by Lauterbach. The leaf-blades are often deciduously farinose-puberulent beneath. A description of the fruits, based on the cited material, follows:

Fruiting inflorescences compact, hardly exceeding 4 cm. in length (including fruits), the peduncles and pedicels stout, farinose-puberulent, the pedicels (above ultimate articulations) 5–8 mm. long; fruits usually reduced to 1 per inflorescence, glabrous, subglobose, at maturity about 2.5 cm. in diameter, the pericarp 4–8 mm. thick, smooth, the mesocarp spongy; seed ovoid.

Calophyllum (§ *Inophyllum*) **pauciflorum** sp. nov.

Arbor grandis ubique praeter partes novellas evanescenter ferrugineo-puberulas glabra, ramulis gracilibus novellis quadrangularibus demum teretibus et cinereis; petiolis rugulosis canaliculatis 3–10 mm. longis;

laminis coriaceis rhomboideo-ellipticis vel -obovatis, 3–7.5 cm. longis, 1.5–3.5 cm. latis, basi acutis, apice obtusis vel rotundatis, margine incrassatis et saepe recurvatis, subtus minute sed copiose glanduloso-punctulatis, costa supra elevata et basim versus leviter canaliculata subtus prominente carinata, nervis lateralibus numerosissimis (18–25 per centimetrum) obliquis supra subimmersis subtus prominulis; inflorescentiis apices ramulorum versus axillaribus racemosis vel reductis et simplicioribus 1–3-floris, sub anthesi 1–1.5 cm. longis, pedunculo brevi et pedicellis (3–5 mm. longis) incrassatis, bracteis mox caducis; floribus sub anthesi 7–10 mm. diametro; sepalis 4, 2 exterioribus papyraceis late suborbicularibus, circiter 4 mm. longis et 4.5–5 mm. latis, glabris vel interdum extus inconspicue puberulis, 2 interioribus ut petalis similibus; petalis 4 submembranaceis obovato-suborbicularibus, 6–7.5 mm. longis et latis, arcte nervatis, margine scariosis et puberulenti-ciliolatis; staminibus numerosissimis (circiter 100), filamentis gracillimis filiformibus ad 6 mm. longis, antheris oblongis circiter 2 mm. longis apice mucronulatis; ovario glabro ovoideo sub anthesi circiter 2 mm. longo, stylo crasso ovarium aequante, stigmatibus peltatis circiter 2 mm. diametro margine crenulato obscure trifido; inflorescentiis sub fructu brevibus (fructibus inclusis ad 3 cm. longis), pedunculo pedicellisque paullo incrassatis, fructibus plerumque solitariis subglobosis maturitate (?) ad 17 mm. diametro, apice stylo subpersistente coronatis, pericarpio 2–3 mm. crasso extus levi.

NORTHEASTERN NEW GUINEA: Morobe District, Yunzaing, alt. 1250–1550 m., *Clemens* 2378 (TYPE), Apr. 21, 1936 (large tree, in Mt. Alok forest; flowers white; anthers golden), *Clemens* 3849; Ogeramang, alt. 1700 m., *Clemens* 4955. The type bears flowers, 3849 fruits, and 4955 flower-buds.

Calophyllum pauciflorum appears to be a close relative of *C. papuanum* Lauterb., from which it differs in its essentially glabrous habit, its somewhat rhomboid (rather than lanceolate-elliptic) leaf-blades which are smaller on the average, its more compact inflorescences, its much smaller flowers, its glabrous or puberulent (rather than furfuraceous) outer sepals, its much longer anthers with conspicuously elongate filaments, and its glabrous (rather than tomentose) ovary.

***Calophyllum* (§ *Inophyllum*) *congestiflorum* sp. nov.**

Arbor 18–25 m. alta ubique sub anthesi glabra, ramulis juventute quadrangularibus mox teretibus et cinereis; petiolis rugulosis canaliculatis 2–5 mm. longis; laminis coriaceis oblongo- vel obovato-ellipticis, 2.5–5 cm. longis, 1.3–3 cm. latis, basi obtusis, apice rotundatis vel in-

terdum leviter emarginatis, margine paullo incrassatis, subtus inconspicue sed copiose glanduloso-punctulatis, costa supra canaliculata interdum paullo elevata subtus prominente carinata, nervis lateralibus numerosissimis (20–30 per centimetrum) patentibus supra subimmersis subtus leviter prominulis vel subplanis; inflorescentiis apices ramulorum versus axillaribus congestis breviter racemosis 1–3-floris, sub anthesi 7–10 mm. longis, pedunculo pedicellisque brevissimis paullo incrassatis, bracteis mox caducis; floribus sub anthesi 6–9 mm. diametro; sepalis 4, 2 exterioribus papyraceis late suborbicularibus, circiter 3 mm. longis, 3.5–4 mm. latis, glabris, margine puberulenti-ciliolatis, 2 interioribus ut petalis similibus; petalis 4 mox caducis submembranaceis late obovatis, 4.5–5.5 mm. longis et latis, arcte nervatis, margine puberulenti-ciliolatis; staminibus numerosis (30–50), filamentis filiformibus 1.5–3 mm. longis, antheris oblongis 0.7–1 mm. longis apice obtusis; ovario glabro subgloboso sub anthesi circiter 2 mm. diametro, stylo brevi crasso, stigmate juvenili non viso sub anthesi ut videtur subpeltato; inflorescentiis sub fructu brevibus, fructibus plerumque solitariis subglobosis immaturis ad 12 mm. diametro, apice stylo coronatis, pericarpio tenui levi vel siccitate ruguloso.

NETHERLANDS NEW GUINEA: 15 km. southwest of Bernhard Camp, Idenburg River, alt. 1800 m., *Brass & Versteegh 11902* (TYPE), Jan. 10, 1939 (tree 18 m. high, frequent in mossy forest on crests of ridges, the trunk 40 cm. diam., the crown small; bark 8 mm. thick, dark brown, fairly smooth, with light yellow resin; sap-wood rose; heart-wood red; flowers white), *Brass 12122* (tree up to about 25 m. high, a mossy forest co-dominant, the trunk about 80 cm. diam.; sap somewhat milky; wood pale and soft, an excellent fuel when green; flowers white); 8 km. southwest of Bernhard Camp, alt. 1600 m., *Brass 12721* (tree 20 m. high, in mossy forest, the trunk 25 cm. diam.; fruit immature). BRITISH NEW GUINEA: Western Division, Palmer River, 2 miles below junction with Black River, ? *Brass 7099* (canopy tree with spurred trunk, plentiful in ridge-forests, the bark thick, flaky, yellowish, suberose; crown compact, the leaves rigid; immature fruit about 1 cm. diam.).

Calophyllum congestiflorum appears to represent a continuation of the trend toward reduced inflorescences and smaller flowers, seen in the preceding new species (*C. pauciflorum*), both of these species being related to *C. papuanum* Lauterb. *Calophyllum congestiflorum* differs from *C. pauciflorum* not only in its more compact inflorescences and smaller flowers, but also in its much shorter anthers and filaments. This latter character does not necessarily follow the size of the flowers, since *C. papuanum*, with large flowers, has small anthers. The new

species differs from *C. papuanum* in its glabrous habit and small leaves, as well as in obvious floral characters.

The type and 12122 bear flowers, 12721 immature fruits. The specimen from the Palmer River is questionably referred to this species. It bears immature fruits and has foliage very similar to that of the other cited specimens, but with a trace of furfuraceous puberulence on the lower surface of the costa and with even more obscure glandular punctation. It may represent an undescribed species; should it prove to belong to *C. congestiflorum*, the species will have an unusually broad altitudinal range.

Both *C. congestiflorum* and *C. pauciflorum* bear a marked resemblance to the Fijian *C. cerasiferum* Vesque (known only in fruiting condition), a species with slightly larger (on the average) leaf-blades with closer lateral nerves and less obvious glandular punctations on the lower surfaces.

Calophyllum (§ *Inophyllum*) **costatum** F. M. Bailey, Queensl. Fl. 104. 1899; Compr. Cat. Queensl. Pl. fig. 40. 1913.

BRITISH NEW GUINEA: Western Division, Gaima, Lower Fly River (east bank), Brass 8337 (rain-forest canopy tree attaining 25–30 m. in height, the bark thick, scaly, secreting a green glutinous sap; outer wood ripple-marked; flowers white).

Originally based on a fruiting specimen collected in Queensland by Bailey, *C. costatum* has not previously been reported from New Guinea. Having compared the Brass specimen with the cited plate and a sterile specimen collected in North Queensland by C. T. White, I feel reasonably sure of the determination. However, it is conceivable that collection of flowering specimens in Queensland will establish the specific distinctness of our plant, in which case it probably represents a new species; it is none of those treated by Lauterbach (loc. cit. 8–14), being only distantly related to *C. papuanum* Lauterb. The inflorescences of the Brass specimen are here described:

Inflorescences axillary toward apices of branchlets, racemose, usually 1–3-flowered, 1–2 cm. long at anthesis, the peduncle short, deciduously puberulent, the pedicels slender, 3–5 mm. long, the bracts small, caducous; flowers about 10 mm. in diameter at anthesis; sepals 4, the 2 outer ones papyraceous, suborbicular, 3–4 mm. in diameter, glabrous, with faintly puberulent-ciliolate margins, the 2 inner ones similar to petals; petals 4, membranous, obovate-elliptic, at anthesis 5–6 mm. long and 3–4.5 mm. broad, glabrous, obscurely ciliolate at margins, finely nerved, often reflexed at margins; stamens 50–60, the filaments filiform, 3–4 mm. long at anthesis, the anthers oblong, about 2.5 mm.

long, mucronulate at apex; ovary glabrous, ellipsoid, 1.5–2 mm. long at anthesis, the style equalling the ovary, the stigma peltate, 1.5–2 mm. in diameter, irregularly bifid, crenulate at margins.

Calophyllum (§ *Inophyllum*?) **Brassii** sp. nov.

Arbor ad 20 m. alta sub fructu ubique praeter ramulos inflorescentiarum decidue ferrugineo- vel cinereo-puberulos glabra, ramulis robustis (apicem versus 4–6 mm. diametro) leviter angulatis et saepe striatis demum subteretibus et cinereis, interdum conspicue lenticellatis; petiolis rugosis crassis (3–5 mm. diametro) 2–4 mm. longis; laminis crasse coriaceis subnitidis oblongis, 12–17 cm. longis, 5–6 cm. latis, basi rotundatis, apice ut videtur rotundatis vel obtusis, margine incrassatis et conspicue sed anguste recurvatis, costa valida supra leviter elevata (inferne canaliculata superne carinata) subtus valde prominente, nervis lateralibus numerosis (16–28 per centimetrum) patentibus subrectis utrinque inconspicue prominulis; inflorescentiis sub fructu apices ramulorum versus axillaribus paniculatis fructibus inclusis ad 6.5 cm. longis et 8 cm. latis, pedunculo brevissimo, ramulis paucis et rhachi rugosis angulatis robustis (2–3 mm. diametro), pedicellis 8–24 mm. longis crassis superne leviter incrassatis; fructibus pluribus (5–8 vel ultra) per inflorescentiam ovoideo-subglobosis, ut videtur maturitate et siccitate ad 13 mm. diametro, apice obtusis et stylo brevi saepe coronatis, pericarpio siccitate circiter 2 mm. crasso extra demum rugoso, epicarpio tenui, mesocarpio suberoso.

NETHERLANDS NEW GUINEA: 4 km. southwest of Bernhard Camp, Idenburg River, alt. 850 m., *Brass & Versteegh 13122* (TYPE), March 7, 1939 (tree 20 m. high, frequent in primary rain-forest on the flat plain, the trunk 55 cm. in diameter, the crown not wide-spreading; bark 14 mm. thick, brown, scaly, with pale yellow sap, the sap-wood brown, the heart-wood dark brown; fruits green).

Calophyllum Brassii is a species characterized by its unusually thick oblong leaf-blades with very short petioles. Known only from the cited fruiting specimen, the species cannot be accurately placed within the genus, but its comparatively short paniculate inflorescences suggest *C. Kiong* Lauterb. & K. Schum., perhaps its closest ally. *Calophyllum Brassii* differs from *C. Kiong* in having short petioles, leaf-blades narrower and rounded rather than cuneate or acute at base, and lateral nerves less obvious and less crowded.

Calophyllum savannarum sp. nov.

Arbor 10–12 m. alta sub fructu ubique glabra, ramulis gracilibus juventute leviter complanatis vel angulatis mox subteretibus et fusco-

cinereis ad nodos paullo incrassatis; petiolis leviter canaliculatis vel complanatis 9–17 mm. longis; laminis coriaceis siccitate fusco-olivaceis anguste elliptico-oblongis, 8–13 cm. longis, 3.5–5.5 cm. latis, basi acutis et in petiolum decurrentibus, apice gradatim acuminatis (acumine ad 1 cm. longo obtuso), margine leviter incrassatis et paullo recurvatis, costa supra elevata et basim versus canaliculata subtus prominente et saepe carinata, nervis lateralibus valde adscendentibus subrectis 10–16 per centimetrum utrinque valde prominulis; inflorescentiis sub fructu axillaribus vel subterminalibus racemosis fructibus inclusis 3–9 cm. longis, rhachi gracili (1–2 mm. diametro), pedicellis 6–15 mm. longis superne incrassatis, fructibus ut videtur 3–7 per inflorescentiam vel interdum paucioribus ellipsoideis maturitate ad 22 mm. longis et 15 mm. latis, apice rotundatis et stylo saepe apiculatis, basi rotundatis, epicarpio tenui levi glaucescente, mesocarpio suberoso.

NETHERLANDS NEW GUINEA: Vicinity of Hollandia, alt. 20–100 m., *Brass* 8888 (TYPE), June 29, 1938 (tree 10–12 m. high, one of the principal species of forest clumps on secondary savannas; fruits blue).

Calophyllum savannarum, although represented by a fruiting specimen only, is quite distinct among species of *Calophyllum* in the region in its conspicuous lateral nerves, which ascend at an angle approaching 45°. Among Papuan species, it seems most suggestive of *C. Sil* Lauterb., differing in its venation, its leaf-shape, its longer fruiting pedicels, and its somewhat larger fruits. The true relationship of the new species is hardly to be ascertained until flowers are available.

***Calophyllum Kajewskii* sp. nov.**

Arbor grandis sub fructu ubique glabra, ramulis crassis (apices versus 4–6 mm. diametro) purpurascentibus rugosis demum fuscis et lenticellatis; petiolis crassis (circiter 3 mm. diametro) rugosis 15–20 mm. longis leviter canaliculatis; laminis coriaceis subnitidis oblongo- vel obovato-ellipticis, 14–17 cm. longis, 6–9 cm. latis, basi acutis et in petiolum decurrentibus, apice rotundatis, margine conspicue incrassatis et saepe leviter recurvatis, costa valida supra valde elevata (inferne canaliculata superne carinata) subtus prominente et carinata, nervis lateralibus numerosis (14–20 per centimetrum) erecto-patentibus subrectis utrinque prominulis; inflorescentiis non visis; fructibus magnis subglobosis 5–6 cm. diametro, longitudinaliter multicostatis (costis non conspicuis sed facile distinguitur), basi et apice rotundatis, pericarpio lignoso 10–15 mm. crasso.

SOLOMON ISLANDS: Bougainville: Koniguru, Buin, alt. 800 m., *Kajewski* 2024 (TYPE), Aug. 6, 1930 (large rain-forest giant,

common, the bark slightly furrowed; fruit green, more or less globular, with slightly raised ridges; native name: *sikoraku*); Siwai, *Waterhouse 201* (NY) (large tree with orange-like fruit; native names: *huwau*, *manuba*, *galukoko*, *bunkbuni*).

Although it is represented only by foliage and a single detached fruit accompanying the type, in which condition it cannot be referred to a section, the cited specimens are so distinct that I venture to describe them as new. No *Calophyllum* thus far known from the region, as far as I can ascertain, has such an extremely large and woody fruit. The foliage of *C. Kajewskii* closely resembles that of the lowland *C. inophyllum* L., which, of course, has a very different fruit. The only available sheet of *Waterhouse 201* is sterile, but its foliage and the note implying the size of the fruit strongly suggest *C. Kajewskii*.

GARCINIA L.

Garcinia (§ *Xanthochymus*) **Warburgiana** nom. nov.

Xanthochymus novo-guineensis Warb. Bot. Jahrb. 13: 381. 1891.

Garcinia novo-guineensis Warb. ex Lauterb. Nova Guinea Bot. 8: 309. 1910; Bot. Jahrb. 58: 19. 1922; non Vesque (1893).

The necessity for applying a new name to this species arises from the fact that Warburg's parenthetical mention of *Garcinia* does not alter his acceptance of *Xanthochymus* as the genus of his new species. *Garcinia novo-guineensis* Vesque was referred by Lauterbach to *G. Edelfeldtii* (Lauterb. Bot. Jahrb. 58: 21. 1922), which is therefore an unnecessary binomial. Although known from several specimens from other sections of New Guinea, *G. Warburgiana* has not previously been reported from British New Guinea, where it is represented by the following collections:

BRITISH NEW GUINEA: Koitaki, alt. 450 m., *Carr 12727* (NY) (tree 25 m. high; fruit green), *Carr 12735* (NY) (tree 12 m. high; buds green); Western Division, Mabaduan, *Brass 6489* (common in monsoon-forest substage; excurrent richly branched tree attaining 20 m., exuding a cream colored latex when cut; leaf-blades stiff, the largest ones about 30 cm. long, at ends of branchlets, the nerves deeply impressed above, prominent beneath; fruit pale yellow, about 3.5 cm. diam.); Lower Fly River, east bank opposite Sturt Island, *Brass 7976* (sub-canopy tree to 25 m. high, occasional on ridges in rain-forest, the bark hard, slightly scaly, the latex white; flowers greenish white).

Our specimens have the leaf-blades considerably larger than those previously described; according to Brass' notes these attain a size of

30 cm. long and presumably about 17 cm. broad. The staminate flowers of *Brass* 7976 are also unusually large, with petals up to 9 mm. long and broad and phalanges up to 7 mm. long.

***Garcinia* (§ *Cambogia*) *angustifolia* sp. nov.**

Arbor gracilis glabra ad 5 m. alta, ramulis gracilibus (apicem versus 1–2 mm. crassis) cinereis juventute inconspicue quadrangulatis demum teretibus; petiolis gracilibus (0.5–1 mm. diametro) canaliculatis 6–10 mm. longis, basi foveola inconspicua praeditis; laminis membranaceis vel tenuiter papyraceis siccitate fusco-viridibus lanceolato-oblongis, 8–14 cm. longis, 2–3.5 cm. latis, basi subattenuatis et in petiolum decurrentibus, apice cuspidatis vel abrupte acuminatis (acumine 3–8 mm. longo obtuso), margine integris, costa supra paullo canaliculata et saepe inconspicue elevata subtus prominente, nervis lateralibus utrinsecus 15–20 (cum nervis debilioribus interdum interspersis) erecto-patentibus utrinque prominulis nervo marginali conjunctis, venulis inconspicuis; inflorescentiis in axillis foliorum saepe delapsorum pulvinatis, floribus ♂ paucis (juvenilibus 3–5 sed sub anthesi plerumque 1) sessilibus sub anthesi circiter 5 mm. longis et 4 mm. diametro, bracteis inconspicuis deltoideis suffultis; sepalis 4 subaequalibus anguste imbricatis papyraceis ovato-deltoideis, 1.5–2 mm. longis et latis, apice rotundatis, margine scariosis et integris vel minute erosulis; petalis 4 valvatis sub anthesi suberectis tenuiter carnosis obovato-lanceolatis, 3.5–4 mm. longis, 1–1.3 mm. latis, apice rotundatis, margine subintegris; staminibus 5 vel 6 liberis toro carnosio subtereti erecto 1–1.5 mm. longo insertis, antheris 1- vel 2-seriatis sessilibus oblongis, circiter 1 mm. longis et 0.5 mm. latis, apice truncatis vel minutissime papillosis, loculis 2 rimis elongatis lateralibus dehiscentibus; ovario nullo.

NETHERLANDS NEW GUINEA: Vicinity of Hollandia, alt. 100 m., *Brass* 8990 (TYPE), July 8, 1938 (tree 5 m. high, occasional in rain-forest undergrowth).

Garcinia angustifolia is characterized by its thin and narrow leaf-blades and the reduced number of its stamens. It is a close relative of *G. pachypetala* Lauterb., a montane species; although mature flowers of *G. pachypetala* have not been described, they have 8–10 stamens and are apparently larger than those of the new species.

***Garcinia* (§ *Cambogia*) *pachyantha* sp. nov.**

Arbor parva glabra, ramulis crassis (apicem versus 2–4 mm. crassis) juventute paullo complanatis mox teretibus et cinereis; petiolis rugulosis leviter canaliculatis 10–22 mm. longis, basi foveola inconspicua praeditis; laminis papyraceis vel chartaceis elliptico-oblongis, 8–17 cm. longis, 3–6.5

cm. latis, basi subattenuatis et in petiolum decurrentibus, apice abrupte acuminatis (acumine 5–10 mm. longo obtuso), margine integris et anguste recurvatis, costa supra leviter canaliculata subtus prominente, nervis lateralibus utrinsecus 15–20 erecto-patentibus interdum furcatis cum aliis brevioribus interspersis utrinque prominulis nervo marginali conjunctis, venulis subimmersis; floribus ♂ paucis (plerumque sub anthesi singulis) ex pulvinis conspicuis axillaribus sessilibus, sub anthesi 14–16 mm. diametro, bracteis inconspicuis mox deciduis suffultis; sepalis 4 papyraceis vel submembranaceis anguste imbricatis late semiorbicularibus, 2.5–3.5 mm. longis, 4–5.5 mm. latis, apice rotundatis, margine integris et scariosis; petalis 4 anguste imbricatis carnosis oblongis, 7–8 mm. longis, 4–5 mm. latis, apice rotundatis, margine anguste scariosis et integris; staminibus 21–25 liberis toro applanato vel paullo convexo insertis, antheris sessilibus oblongis, 1.5–1.8 mm. longis, circiter 1 mm. latis, apice truncatis, connectivo crasso, loculis 2 rimis elongatis lateralibus dehiscentibus; ovario nullo; fructibus axillaribus sessilibus ut videtur subglobosis et ad 2.5 cm. diametro, basi sepalis persistentibus suffultis, apice stigmate sessili circiter 5 mm. diametro coronatis, seminibus plus minusve 10, pericarpio carnoso.

NORTHEASTERN NEW GUINEA: Morobe District, Sattelberg, alt. 1030 m., *Clemens 3080* (TYPE), May 12, 1936 (on forest hill above mission; flowers white); Yunzaing, alt. 1400 m., *Clemens 3597A* (tree, the trunk 13–15 cm. diam., along forest trail), *Clemens 4183* (small tree, the trunk about 13 cm. diam.; fruit green). Nos. 3080 and 3597A bear ♂ flowers; no. 4183 is accompanied by a few badly dried fruits.

Garcinia pachyantha is related to *G. fruticosa* Lauterb., differing in its proportionately broader leaf-blades with more numerous lateral nerves, its longer petioles, its larger flowers, especially as regards the carnosae petals, and its fewer stamens (21–25 rather than about 30).

***Garcinia* (§ *Cambogia*) *riparia* sp. nov.**

Arbor glabra 5–15 m. alta, ramulis ut videtur elongatis subteretibus (apicem versus complanatis) juventute fuscis demum cinereis; petiolis circiter 2 mm. crassis leviter canaliculatis 15–22 mm. longis, basi foveola deltoidea inconspicua ornatis; laminis tenuiter papyraceis elliptico-oblongis, 12–20 cm. longis, 5.5–9 cm. latis, basi acutis vel gradatim attenuatis et in petiolum decurrentibus, apice cuspidatis vel acuminatis (acumine ad 15 mm. longo obtuso), margine integris et anguste recurvatis, costa supra paullo elevata et obscure striata vel canaliculata subtus prominente, nervis lateralibus utrinsecus 8–12 adscendentibus

vel erecto-patentibus utrinque conspicue elevatis marginem versus valde adscendentibus, rete venularum inconspicuo vel utrinque paullo prominulo; floribus ♂ paucis (juvenilibus ut videtur pluribus sed sub anthesi plerumque 1 vel 2) ex pulvinis conspicuis (ad 7 mm. diametro) in axillis foliorum delapsorum sessilibus, sub anthesi ad 15 mm. diametro, bracteis minutis suffultis; sepalis 4 papyraceis late ovato-semiorbicularibus, circiter 4 mm. longis, 4–5 mm. latis, apice rotundatis, margine scariosis et integris; petalis 4 in alabastro imbricatis sub anthesi crasse carnosius anguste obovato-oblongis, 7–8 mm. longis, 3–4 mm. latis, apice rotundatis, margine integris vel minute erosulis; androecio conspicuo, toro cylindrico crasse carnosio 1.5–2 mm. longo 1–1.3 mm. diametro apice incrassato et stamina 40–50 gerente, antheris subsessilibus confertis oblongis, 0.5–0.6 mm. longis, circiter 0.3 mm. latis, apice truncatis vel leviter emarginatis, loculis 2 rimis verticalibus lateralibus dehiscentibus; ovario nullo; fructibus axillaribus sessilibus subgloboso-obovoideis, maturitate ad 7 cm. longis et 5 cm. latis, basi sepalis persistentibus suffultis, apice rotundatis et stigmate sessili radiatim rugoso circiter 4 mm. diametro coronatis, extra conspicue 7–10-costatis, pericarpio siccitate coriaceo, seminibus 7–10 oblongis in pulpo nidulantibus.

BRITISH NEW GUINEA: Western Division, Sturt Island, Lower Fly River, *Brass* 8154 (TYPE), Oct. 1936 (loosely branched undergrowth tree 5–6 m. high, plentiful in flood-plain rain-forest; flowers pale pink, with a fungus on petals); Lower Fly River, east bank opposite Sturt Island, *Brass* 8025 (weak spreading tree 5–6 m. high, common in undergrowth in rain-forest on flood-plain; leaf-margins recurved; fruit green, broadly pyriform, almost sessile below the leaves); Lake Daviumbu, Middle Fly River, *Brass* 7588 (tree 15 m. high, in rain-forest substage; fruit yellow-green, solitary, sessile on old wood). The type bears ♂ flowers, the other two specimens being in fruit.

Garcinia riparia is a very distinct species of § *Cambogia*, characterized by its thin leaf-blades with comparatively few and ascending lateral nerves, few-flowered inflorescences with large sessile flowers, and a conspicuous columnar androecium with numerous stamens. It appears to be closely related to *G. Ledermannii* Lauterb., from which it differs in its fewer lateral nerves, larger leaf-blades, smaller flowers, especially as regards the petals and androecium, and its larger and conspicuously costate fruits with more numerous seeds.

***Garcinia* (§ *Cambogia*) *solomonensis* sp. nov.**

Arbor glabra ad 25 m. alta, ramulis apicem versus quadrangulatis demum teretibus et fusco-cinereis; petiolis rugulosis canaliculatis 8–12

(-20) mm. longis, basi foveola oblonga inconspicua ornatis; laminis papyraceis siccitate fusco-olivaceis elliptico-oblongis, 8-15 mm. longis, 3.5-6(-8) cm. latis, basi acutis vel attenuatis et in petiolum decurrentibus, apice cuspidatis vel acuminatis (acumine 3-10 mm. longo obtuso), margine integris et anguste revolutis, costa supra subplana vel leviter canaliculata subtus prominente, nervis lateralibus utrinsecus 8-12(-14) erecto-patentibus utrinque valde prominulis marginem versus arcuatis et nervo marginali conjunctis, rete venularum inconspicuo plerumque immerso; floribus ♂ paucis (sub anthesi plerumque solitariis) ex pulvinis interdum conspicuis in axillis foliorum mox delapsorum sessilibus, sub anthesi 5-7 mm. diametro, bracteis 4 imbricatis papyraceis reniformi-suborbicularibus ad 1.5 mm. longis suffultis; sepalis 4 tenuiter carnosius oblongo-suborbicularibus, 2-3.5 mm. longis et latis, apice rotundatis, margine integris; petalis 4 (in specimine nostro ut videtur immaturis) carnosius oblongis, 2-2.5 mm. longis, 1-1.5 mm. latis, apice rotundatis, margine integris; staminibus 40-45 congestis toro leviter convexo insertis, antheris subsessilibus liberis multiseriatis oblongis, circiter 0.35 mm. longis et 0.25 mm. latis, apice truncatis, basim versus paullo angustatis, connectivo leviter incrassato, loculis 2 rimis verticalibus lateralibus dehiscentibus; ovario nullo; fructibus axillaribus sessilibus subglobosis vel ellipsoideis, maturitate ut videtur ad 4 cm. diametro, basi sepalis persistentibus suffultis, apice rotundatis et stigmate sessili inconspicuo coronatis, extra inconspicue 7-10-costatis, pericarpio carnoso, seminibus 7-10 in pulpo nidulantibus.

SOLOMON ISLANDS: Bougainville: Siwai, *Waterhouse 186* (A, NY, TYPE, Y) Jan. 1933 (small tree about 5 m. high, the trunk about 35 cm. diam.; native name: *pinuhunuhunu*); Kugumaru, Buin, alt. 150 m., *Kajewski 1816* (medium-sized tree up to 20 m. high, common in rain-forest; bark with a yellow sap; fruit green, with yellow sap; native name: *na-boita*); Lake Luralu, Koniguru, Buin, alt. 1500 m. ?*Kajewski 2063* (small tree, common among stunted vegetation in rain-forest; leaves purple-veined; fruit plum colored; native name: *sipego*); Kupei Gold Field, alt. 950 m., ?*Kajewski 1673* (tree up to 25 m. high, common in rain-forest; fruit yellow-red when ripe). Guadacanal: Ma-massa, Konga, alt. 500 m., *Kajewski 2484* (tree to 18 m. high, common in rain-forest; fruit apple-shaped, yellow-green when ripe, with pleasant fragrance and not abundant pulp).

Of the cited specimens, only the type collection is in flower; the others bear fruits, but only *Kajewski 2484* appears to have a ripe fruit. The two questioned *Kajewski* collections are dubiously included in this species; they occur at higher elevations than the others and have thicker

leaf-blades with more robust petioles; their fruits, although young, appear to be proportionately longer than those of *Kajewski 1816* and *2484*, of which the former especially is a good foliage match for the type.

Garcinia solomonensis is characterized by its sessile and usually solitary flowers with numerous stamens. Its relationship is probably with *G. Ledermannii* Lauterb. and *G. Assugu* Lauterb., but it differs from the first in such obvious characters as its fewer secondary nerves, small flowers, and inconspicuous androecium-torus, and from the second in its few flowers, small anthers, few secondary nerves, etc.

***Garcinia* (§ *Cambogia*) *macrantha* sp. nov.**

Arbor parva glabra, ramulis crassis (apicem versus 5–7 mm. diametro) rugosis juventute quadrangulatis demum subteretibus; petiolis crassis (3–5 mm. diametro) rugosis leviter canaliculatis 15–30 mm. longis, basi foveola conspicua oblonga ad 10 mm. longa ornatis; laminis tenuiter coriaceis vel chartaceis amplis siccitate fusco-olivaceis elliptico-oblongis, 18–32 cm. longis, 8–14 cm. latis, basi obtusis vel rotundatis et in petiolum paullo decurrentibus, apice obtusis vel obtuse cuspidatis, margine integris vel undulatis et leviter recurvatis, costa supra paullo elevata et saepe striata vel canaliculata subtus valde prominente et saepe carinata, nervis lateralibus utrinsecus 25–35 (cum nervis brevioribus debilioribus copiose interspersis) erecto-patentibus subrectis utrinque prominulis nervo marginali distincto conjunctis, rete venularum inconspicuo plerumque immerso; floribus ♂ apice ramulorum fasciculatis ex pulvinis inconspicuis inter folia terminales orientibus 7–10 per inflorescentiam, sub anthesi 30–40 mm. diametro, bracteis paucis papyraceis oblongo-deltoides acutis ad 10 mm. longis suffultis; pedicellis teretibus crassis (2–3 mm. diametro) ad 18 mm. longis apicem versus incrassatis; sepalis 4 imbricatis, 2 exterioribus tenuiter coriaceis valde concavis late ovato-oblongis, 10–13 mm. longis, circiter 15 mm. latis, apice rotundatis, margine anguste scariosis et integris, 2 interioribus petalis similibus; petalis 4 carnosis sub anthesi patentibus sub-orbiculari-oblongis, 16–19 mm. longis, 12–15 mm. latis, apice rotundatis, margine anguste scariosis et integris, longitudinaliter dense sed inconspicue et irregulariter glanduloso-lineolatis; androecio conspicuo, toro semigloboso carnoso sub anthesi 5–8 mm. alto et circiter 10 mm. diametro, staminibus numerosissimis (circiter 200) confertis torum tegentibus, filamentis carnosis subteretibus 0.2–0.7 mm. longis, antheris crasse carnosis oblongis, 1.3–2 mm. longis, 0.8–1.2 mm. latis, saepe conspicue falcatis, apice obtusis, loculis 2 rimis conspicuis elongatis introrsis dehiscentibus; gynaeceii rudimento parvo carnoso apice tori

inserto circiter 1.5 mm. longo, stigmatē peltato circiter 2 mm. diametro margine paullo undulato.

BRITISH NEW GUINEA: Western Division, Lower Fly River, east bank opposite Sturt Island, *Brass 8092* (TYPE), Oct. 1936 (sparse tree, in undergrowth on ridges in rain-forest; latex drying bluish white; leaf-venation dark beneath; flowers brownish pink).

Although there seems no doubt that *G. macrantha* belongs in § *Cambogia*, it is so distinct from other species of the region as to make comparison superfluous. It is characterized by its remarkably large and coarse leaves and flowers, terminal inflorescences, conspicuous pedicels, the great number of its stamens, and the presence of a gynaeceum-rudiment on the summit of the conspicuous antheriferous torus.

***Garcinia* (§ *Cambogia*) *balimensis* sp. nov.**

Arbor parva glabra, ramulis crassis (apicem versus 4–5 mm. diametro) rugosis subteretibus (vel distaliter leviter complanatis) cinereis; petiolis rugosis 2–3 mm. diametro 7–15 mm. longis, basi foveola conspicua elliptica margine incrassata instructis; laminis tenuiter coriaceis siccitate fuscis late ellipticis, 8–12.5 cm. longis, 5–8 cm. latis, basi late obtusis, apice rotundatis vel obtusis et saepe leviter emarginatis, costa supra leviter canaliculata subtus valde prominente, nervis lateralibus utrinsecus circiter 20 (cum nervis paullo debilioribus alternatis) patentibus utrinque valde prominulis nervo marginali conjunctis, venulis inconspicuis interdum paullo prominulis; floribus ♀ axillaribus sessilibus solitariis sub anthesi 17–20 mm. diametro, bracteis 4 late imbricatis papyraceis reniformibus circiter 2 mm. longis et 4.5 mm. latis rotundatis integris subtentis; sepalis 4 subaequalibus imbricatis submembranaceis late semiorbicularibus, 4–5 mm. longis, circiter 8 mm. latis, apice rotundatis, margine integris, dense glanduloso-lineolatis; petalis 4 anguste imbricatis crasse carnosae obovato-oblongis, circiter 10 mm. longis, 6–7 mm. latis, apice rotundatis, margine anguste scariosis et subintegris; staminodiis 16–18 uniseriatis circiter 3 mm. longis breviter stipitatis oblongis subacutis, loculis 2 longitudinalibus ut videtur rimis verticalibus dehiscentibus; ovario breviter cylindrico rugoso sub anthesi circiter 3 mm. diametro, loculis 8–12 uniovulatis, stigmatē 3–4 mm. diametro conspicue papilloso margine irregulariter lobato; fructibus axillaribus sessilibus subglobosis vel paullo complanatis, ad 3.5 cm. diametro (maturis ?), basi sepalis persistentibus suffultis, apice stigmatē radiatim rugoso coronatis, pericarpio siccitate valde rugoso, seminibus 8–12 in pulpo sparso nidulantibus.

NETHERLANDS NEW GUINEA: Balim River, alt. 2100 m., *Brass* 11753 (TYPE), Dec. 1938 (small tree in secondary forest; flowers yellow; fruit green).

Garcinia balimensis, although represented only by a specimen with pistillate flowers, seems to belong to § *Cambogia* by virtue of its several-celled ovary, is oblong staminodes arranged in a single row, and its solitary sessile flowers. It is characterized by coriaceous and proportionately broad leaf-blades and large flowers. Although I cannot place it as a close ally of any described Papuan species, *G. balimensis* seems amply distinguished from those described by the above-mentioned combination of characters.

***Garcinia* (§ *Discostigma*) *Warrenii* F. v. Muell. Vict. Naturalist 8: 109. 1891; Vesque in DC. Monogr. Phan. 8: 641. 1893; Lauterb. Bot. Jahrb. 58: 24. fig. 5. 1922.**

Garcinia Branderhorstii Lauterb. Nova Guin. Bot. 8: 311. 1910.

BRITISH NEW GUINEA: Central Division, Biriatabu, alt. 460 m., *Brass* 568 (shapely tree 15 m. high, the bark light brown, somewhat scaly, the wood pale brown, used by natives for building and for handles of weapons; fruit with bright yellow sticky latex; native name: *fareti*); Hewa, Vailala River, *Brass* 1117 (small compact tree 15 m. high, with stiff branches, on clay ridges close to sago swamps; fruit brown, eaten by natives; native name: *ekobu*); Western Division, Lower Fly River, east bank opposite Sturt Island, *Brass* 7996 (rain-forest substage tree, plentiful on ridges, the bark brown-black, somewhat scaly; flowers cream colored); Lake Daviumbu, Middle Fly River, *Brass* 7471 (tree up to 14 m. high, abundant in lake-shore substage, the branches spreading, the bark gray-black, shallowly fissured; flowers cream colored, fragrant); Tarara, Wassi Kussa River, *Brass* 8430 (tree 10 m. high, common in rain-forest on clay banks of river; fruit red, subglobose, 3–3.5 cm. diam.; latex yellow).

The cited specimens surely represent *G. Branderhorstii*, which Lauterbach refers without question to the Queensland species *G. Warrenii*. Previously this species has been known from southern Netherlands New Guinea as well as Queensland.

***Garcinia* (§ *Tetrachoristemon*) *Lauterbachiana* sp. nov.**

Frutex glabra, ramulis gracilibus apicem versus 0.7–1 mm. crassis quadrangulatis demum subteretibus cinereis; petiolis gracilibus leviter canaliculatis 2–4 mm. longis, basi foveola inconspicua ornatis; laminis submembranaceis vel papyraceis siccitate viridi-olivaceis lanceolato-ellipticis, 2–4.5 cm. longis, 0.7–1.7 cm. latis, basi acutis vel obtusis,

apice obtusis vel obtuse et breviter acuminatis, margine integris et leviter recurvatis, costa utrinque leviter elevata vel supra subplana, nervis lateralibus utrinsecus 3–5 adscendentibus nonnunquam furcatis utrinque paullo prominulis nervo marginali indistincte conjunctis, rete venularum immerso; stipulis membranaceis saepe conspicuis ad 5 mm. longis caducis, floribus ♂ solitariis (vel paucis?) ex pulvinis inconspicuis subsessilibus (pedicellis circiter 1.5 mm. longis), alabastro ellipsoideo circiter 2.5 mm. longo et 2 mm. diametro; sepalis 4 membranaceis elliptico-oblongis, circiter 2 mm. longis et 1.5 mm. latis, apice rotundatis, margine minute erosulis, conspicue longitudinaliter venosis; petalis 4 obovato-oblongis, 2.5–3 mm. longis, circiter 1 mm. latis, inferne carnosis superne submembranaceis, apice rotundatis, margine apicem versus scariosis et subintegris; staminibus 4 in apice tori inconspicui erectis, filamentis carnosis brevibus (circiter 0.2 mm. longis) basi connatis, antheris obovoideo-oblongis, 1–1.2 mm. longis, apice truncatis et 0.5 mm. latis, basim versus angustatis, rimis lateralibus verticalibus dehiscentibus; ovario nullo.

NORTHEASTERN NEW GUINEA: Morobe District, Ogeramnang, alt. 1700 m., *Clemens* 5441 (TYPE), Feb. 18, 1937; Yunzaing, alt. 1400 m., *Clemens* 2975 (undershrub, on forested hills; buds orange), *Clemens* 6470a; Finisterre Gebirge, alt. 1300 m., *Schlechter* 19105 (A, NY).

The cited specimens are sterile, with the exception of a single nearly mature flower on the type and a few buds on *Clemens* 2975; nevertheless the species is so readily recognized by its foliage that I have no doubt that the specimens are conspecific.

Garcinia Lauterbachiana shows a close affinity with *G. maluensis* Lauterb., the only previously known member of § *Tetrachoristemon*, which it resembles in its habit, stipules, leaf-texture, and floral structure. The new species differs from *G. maluensis* in its remarkably small leaf-blades, its truncate but not apically papillose anther-connectives, and its lack of a gynaeceum-rudiment in the staminate flowers. Otherwise, especially in texture of sepals and petals, the staminate flowers of the two species are nearly identical.

***Garcinia* (§ *Tetrachoristemon*) *rhynchophylla* sp. nov.**

Arbor gracilis 3–4 m. alta glabra, ramulis gracilibus apicem versus 1 mm. vel minus crassis quadrangulatis demum subteretibus cinereis striatis; petiolis gracilibus leviter canaliculatis, 4–5 mm. longis, basi foveola inconspicua praeditis; laminis submembranaceis siccitate viridibus anguste ovato-lanceolatis, 2.5–5 cm. longis, 0.7–1.3 cm. latis, basi acutis, apice caudato-acuminatis (acumine 7–15 mm. longo acuto incon-

spicue calloso), margine integris, costa supra leviter prominula et canaliculata subtus paullo elevata, nervis lateralibus utrinsecus 8–10 (cum aliis debilioribus interspersis) interdum furcatis patentibus utrinque minute prominulis marginem versus indistincte anastomosantibus, venulis intricate ramulosis utrinque minute prominulis vel subimmersis; stipulis linearibus 3–5 mm. longis mox caducis; fructuum pedicellis gracilibus ad 5 mm. longis; fructibus axillaribus subglobosis ad 2.3 cm. diametro (immaturis?), basi sepalis 4 imbricatis papyraceis semiorbicularibus ad 2 mm. longis et 3 mm. latis suffultis, apice rotundatis et stigmate sessili circiter 2 mm. diametro radiatim rugoso coronatis, extra ut videtur levibus, pericarpio tenui, seminibus paucis in pulpo sparso nidulantibus.

NETHERLANDS NEW GUINEA: 6 km. southwest of Bernhard Camp, Idenburg River, alt. 1200 m., *Brass* 12867 (TYPE), Feb. 1939 (tree 3–4 m. high, frequent in rain-forest undergrowth; unripe fruit up to 2.3 cm. diam.).

Garcinia rhynchophylla, based on the above cited fruiting specimen, is almost certainly closely related to *G. Lauterbachiana* (above described), differing in its caudate-acuminate leaf-blades with more numerous and spreading lateral nerves, more obvious veinlets, and presumably pedicellate flowers (as indicated by the pedicels of the fruits).

Garcinia (§ *Hebradendron*) ***subtilinervis*** F. v. Muell. Descr. Notes Pap. Pl. 1: 85. 1877; Vesque in DC. Monogr. Phan. 8: 488. 1893; Lauterb. Nova Guin. Bot. 8: 312. 1910; Lauterb. Bot. Jahrb. 58: 38. 1922.

BRITISH NEW GUINEA: Koitaki, alt. 450 m., *Carr* 12567 (NY), 12795 (NY); Kanosia, sea-level, *Carr* 11299 (?) (NY), 11301 (?) (NY); Western Division, Palmer River, 2 miles below junction with Black River, alt. 100 m., *Brass* 7310 (small slender tree 3 m. high, common in ridge-forest undergrowth; flowers cream colored), *Brass* 7006 (forest substage tree 6–8 m. high, common on low ridges and river-flats; leaves coriaceous, with recurved margins; fruit green, sessile on old wood), *Brass* 7077 (tree 8–10 m. tall, common constituent of ridge-forest substage; branches slender, always heavily mossed; fruit sessile below leaves, pale green); Lower Fly River, east bank opposite Sturt Island, *Brass* 8061 (undergrowth tree 2–3 m. high, in rain-forest on ridges; branches drooping, horizontal; leaf-nerves obscure; fruit red, solitary, sessile).

The cited specimens agree very closely with the original description, although this is so brief that comparison with the type (*D'Albertis* from

the Fly River) is desirable. Nevertheless, I refer our collections to the species with some confidence; they bear a close superficial resemblance to the Indian *G. cowa* Roxb., a point emphasized by Mueller. Lauterbach cited a specimen of *G. subtilinervis* from southern Netherlands New Guinea and referred the species to § *Cambogia* with a question. If my identification is correct, however, the species belongs in § *Hebradendron*. Previous descriptions being incomplete, it seems advisable to redescribe the species on the basis of the above cited specimens:

Glabrous slender tree to 12 m. high, the branchlets slender, distally quadrangular, the older ones subterete and cinereous; petioles slender (usually less than 1 mm. in diameter), shallowly canaliculate, 4–10(–20) mm. long, inconspicuously foveolate at base; leaf-blades papyraceous or submembranaceous when dried, olivaceous, narrowly elliptic or obovate-elliptic, 7–12(–20) cm. long, 3–5(–7.5) cm. broad, obtuse to subattenuate at base, acuminate at apex (acumen 5–15 mm. long, obtuse), entire and narrowly recurved at margins, the costa slightly raised to shallowly impressed above, subprominent beneath, the lateral nerves usually 10–12 per side, arcuate-ascending, prominulous (usually inconspicuously so) on both sides, the veinlets few, inconspicuous, sub-immersed; ♂ flowers few (apparently 2–5 per inflorescence, probably often solitary at anthesis), on inconspicuous axillary glomerules, 3–4 mm. in diameter at anthesis, subtended by minute bracts, pedicellate (pedicels very slender, 2–3 mm. long); sepals 4, membranous, subequal, elliptic-oblong, 1.5–2 mm. long, 1.3–1.5 mm. broad, rounded at apex, entire at margin, few-nerved; petals 4, thin-carnose, obovate-oblong, 2–2.5 mm. long, 1.3–1.5 mm. broad, rounded, entire, soon caducous; androecium erect, 1.3–1.5 mm. long, the stalk carnose, subterete or lightly angled, about 0.5 mm. long, the stamens about 12, congested on the subglobose distal portion of the androecium; filaments carnose, stout, 0.1–0.15 mm. long, the anthers horizontally affixed, peltate, 0.4–0.6 mm. in diameter, 4–8-loculed, dehiscing by a continuous lateral cleft; gynaecium-rudiment lacking; fruit solitary, subsessile on older branchlets, subglobose or slightly flattened, at maturity up to 5.5 cm. in diameter (ex Brass), with subpersistent sepals at base, 8–12-costate (probably inconspicuously so when fresh), the seeds 8–12, imbedded in somewhat fibrous pulp.

Of the cited specimens, only *Brass* 7310 bears flowers; the other Brass specimens are in fruit, no. 7006 having unusually large leaves and the only mature fruits; the Carr specimens are sterile. From the staminal arrangement, the described species is surely a member of § *Hebradendron*, in which, however, it is not closely allied to the only

other Papuan species, *G. fusco-petiolata* Lauterb., a species with free stamens. *Garcinia subtilinervis* is readily distinguished from other members of § *Hebradendron* by its few stamens aggregated and sessile on a short androecium, by its small flowers, and by its thin acuminate leaf-blades.

***Garcinia* (§ *Daedalanthera*) *Hunsteinii* Lauterb. Bot. Jahrb. 58: 40. fig. 8. 1922.**

NETHERLANDS NEW GUINEA: 2-6 km. southwest of Bernhard Camp, Idenburg River, alt. 800-1200 m., *Brass & Versteegh* 12536, 13154, 13531 (trees 25-30 m. high, rare or occasional in primary rain-forest on ridges, the trunk 39-47 cm. diam., the crown small, not wide-spreading, the bark 4-9 mm. thick, gray, fairly smooth, with a little yellow latex, the wood yellow to brown; young fruits green, the ripe ones red).

Reported as fairly abundant between 1000 and 1500 m. elevation in the adjacent portion of Northeastern New Guinea, *G. Hunsteinii* is apparently here first reported from the Netherlands section of the island. Our specimens are in fruit, but agree very well with the original description and figure; they have leaf-blades often slightly larger (up to 10.5 cm. long and 4.5 cm. broad) than those originally described. The coriaceous bluntly acuminate leaf-blades with comparatively few and immersed lateral nerves distinguish the species.

***Garcinia* (§ *Daedalanthera*) *Schraderi* Lauterb. Bot. Jahrb. 58: 43. 1922.**

NETHERLANDS NEW GUINEA: 9 km. northeast of Lake Habbema, alt. about 2680 m., *Brass & Versteegh* 10478 (tree 26 m. high, common in ridge-forests, the trunk 33 cm. diam., the crown not wide-spreading, the bark 11 mm. thick, with yellow latex, brown, fairly rough, the wood soft, yellowish; flowers yellow; young fruits green, the ripe ones brown); 15 km. southwest of Bernhard Camp, Idenburg River, alt. 1780 m., *Brass & Versteegh* 11196 (tree 27 m. high, common in primary forest on the slope of a ridge, the trunk 47 cm. diam., the crown not wide-spreading, the bark 10 mm. thick, dark brown, fairly rough, with yellow latex, the sap-wood light brown, the heart-wood dark brown). NORTHEASTERN NEW GUINEA: Morobe District, Ogeramngang, alt. 1550-1850 m., *Clemens* 4737 (tall tree on forest-ridge, the trunk at least 45 cm. diam.; flowers green), 4622, 5081, 6246.

The species has previously been reported only from Northeastern New Guinea; it is apparently of considerable abundance at an altitude unusually high for the genus.

Garcinia (§ *Daedalanthera*) **Archboldiana** sp. nov.

Arbor glabra ad 25 m. alta, ramulis cinereis crassis (apicem versus 3–4 mm. diametro) juventute complanatis demum subteretibus et rugosis, petiolis 2–3 mm. crassis leviter canaliculatis 6–10 mm. longis nigrescentibus, basi foveola elliptica praeditis; laminis tenuiter coriaceis siccitate fusco- vel viridi-olivaceis elliptico-oblongis, 8–15 cm. longis, 3–6 cm. latis, basi attenuatis et in petiolum decurrentibus, apice rotundatis vel late obtusis, margine integris et anguste recurvatis, costa supra leviter elevata et canaliculata subtus prominente, nervis lateralibus utrinsecus numerosissimis (1–1.5 mm. distantibus et rete venularum irregulariter conjunctis) patentibus nonnunquam furcatis utrinque prominulis nervo marginali conjunctis, venulis subimmersis vel minute prominulis; floribus ♂ paucis (1–3 per inflorescentiam) ex pulvinis inconspicuis in axillis foliorum mox delapsorum orientibus, bracteis coriaceis minutis pluribus subtentis; pedicellis crassis (2–3 mm. diametro) saepe verrucosis 4–6 mm. longis; sepalis 4 imbricatis late orbicularibus concavis rotundatis integris, 2 exterioribus tenuiter coriaceis, circiter 2 mm. longis, 3.5–4 mm. latis, 2 interioribus papyraceis, circiter 4 mm. longis, 6–7.5 mm. latis; petalis 4 imbricatis carnosissimis late ellipticis, 7–10 mm. longis, 5–7 mm. latis, apice rotundatis, margine obscure undulatis; phalangibus 4 basi connatis profunde et conspicue lobatis, 5–6 mm. longis, apicem versus copiose antheriferis; staminibus numerosissimis, antheris subsessilibus subpeltatis vel ellipsoideis, 0.3–0.4 mm. diametro, loculis 3 vel 4 rimis brevibus horizontalibus apicalilateralibus dehiscentibus; ovario nullo.

NETHERLANDS NEW GUINEA: Bernhard Camp, Idenburg River, alt. 300 m., *Brass & Versteegh 13596* (TYPE), April 20, 1939 (tree 25 m. high, rare in primary rain-forest on a ridge, the trunk 64 cm. diam., the crown not wide-spreading, the bark 7 mm. thick, brown, scaly, with some yellow sap, the wood light brown; flowers white).

Garcinia Archboldiana is one of a group of three new species of § *Daedalanthera* characterized by a reduction in the number of anther-locules and the absence of a gynaecium-rudiment in the staminate flowers. These three species are related to *G. Schraderi* Lauterb. and *G. Pullei* Lauterb., differing from both by the anthers and by obvious foliage-characters. *Garcinia Archboldiana* has large leaf-blades and very large flowers for this group of species, and is further characterized by numerous secondary nerves and deeply divided phalanges. The four primary phalanges, in fact, are difficult to observe, as the numerous finer divisions appear essentially free from each other. The extremely small and numerous anthers, with only 3 or 4 locules, also distinguish the new species.

Two other specimens from the same region are possibly conspecific with the type of the new species; these are: 6 km. southwest of Bernhard Camp, alt. 1200 m., *Brass 13011* (tree 25 m. high, in minor canopy of rain-forest, the trunk about 50 cm. diam., the bark smooth, brown; fruit green); 15 km. southwest of Bernhard Camp, alt. 1780 m., *Brass & Versteegh 11199* (tree 25 m. high, occasional in primary forest on the slope of a ridge, the trunk 53 cm. diam., the crown not wide-spreading, the bark 4 mm. thick, scaly, brown, with dark yellow sap, the wood light brown; young fruit green). These plants, occurring at substantially higher elevations than the type, differ from it in their somewhat coarser leaf-blades and petioles; their fruits are subglobose, up to 3 cm. in diameter, with stout pedicels and conspicuous stigmas. Lacking specimens from intermediate elevations, I hesitate definitely to refer these two specimens to *G. Archboldiana*.

***Garcinia* (§ *Daedalanthera*) *Engleriana* sp. nov.**

Arbor glabra ad 28 m. alta, ramulis fusco-cinereis crassis (apicem versus 3–4 mm. diametro et complanatis) demum subteretibus et rugosis; petiolis nigrescentibus circiter 2 mm. diametro semiteretibus 5–8 mm. longis, basi foveola conspicua margine incrassata praeditis; laminis subcoriaceis siccitate fusco-olivaceis elliptico- vel obovato-oblongis, 5–9.5 cm. longis, 2.5–4.5 cm. latis, basi attenuatis et in petiolum decurrentibus, apice rotundatis vel late obtusis, margine integris et interdum conspicue revolutis, costa supra leviter elevata subtus prominente, nervis lateralibus utrinsecus numerosis (1–1.5 mm. distantibus) patentibus raro furcatis utrinque prominulis nervo marginali conjunctis, rete venularum inconspicuo subimmerso; floribus ♂ sub anthesi 1–4 per inflorescentiam 13–15 mm. diametro ex pulvinis conspicuis in axillis foliorum demum delapsorum orientibus, bracteis minutis deltoideis numerosis subtentis; pedicellis 5–11 mm. longis circiter 2 mm. crassis saepe leviter quadrangulatis; sepalis 4 papyraceis vel tenuiter coriaceis semiorbicularibus concavis rotundatis integris, 2 exterioribus 1.5–3 mm. longis et 2.5–3.5 mm. latis, 2 interioribus 5–6 mm. longis et latis; petalis 4 (vel raro 5) tenuiter carnosis obovato-oblongis, 7–8 mm. longis, 5–6 mm. latis, rotundatis, margine anguste scariosis et subintegris vel obscure undulatis; phalangibus circiter 16 patentibus carnosis 5–6 mm. longis, basi connatis, stipite basim versus 1–2 mm. diametro, ramulis paucis apicem versus; staminibus 15–20 per phalangem, filamentis carnosis brevibus (ad 0.4 mm. longis) vel subnullis, antheris subpeltatis vel ellipsoideis, 0.6–0.8 mm. diametro, margine undulatis, loculis 3–7 rimis brevibus horizontalibus apicali-lateralibus interdum confluentibus dehiscentibus; ovario nullo.

NETHERLANDS NEW GUINEA: 18 km. southwest of Bernhard Camp, Idenburg River, alt. 1970 m., *Brass & Versteegh 12508* (TYPE), Feb. 7, 1939 (tree 28 m. high, common in primary forest on slope of a ridge, the trunk 52 cm. diam., the crown not wide-spreading, the bark 4 mm. thick, brown, with yellow latex, the wood white; flowers white); 15 km. southwest of Bernhard Camp, alt. 1800 m., *Brass 12099* (tree 25 m. high, co-dominant in mossy forest, the trunk shortly spurred at base, the bark pale brown, lenticellate, with copious yellow latex; flowers white).

Like the preceding new species (*G. Archboldiana*), *G. Engleriana* differs from other species of the section in its deeply divided phalanges and comparatively few anther-locules. In the present species the phalanges are so deeply divided that the presumably fundamental four are no longer discernible. The anthers are larger than those of *G. Archboldiana* and there are obvious floral and foliage differences between the two species.

***Garcinia* (§ *Daedalanthera*) *idenburgensis* sp. nov.**

Arbor glabra ad 33 m. alta, ramulis fusco-cinereis apicem versus 1.5–2 mm. crassis obscure quadrangulatis demum teretibus; petiolis nigrescentibus circiter 1.5 mm. diametro leviter canaliculatis 7–11 mm. longis, basi foveola inconspicua ornatis; laminis subcoriaceis siccitate fusco-viridibus obovato-ellipticis, 7–11 cm. longis, 3.5–5 cm. latis, basi attenuatis et in petiolum decurrentibus, apice obtuse cuspidatis, margine integris et minute revolutis, costa supra paullo subtus valde elevata, nervis lateralibus utrinsecus numerosis (1–1.5 mm. distantibus) erecto-patentibus raro furcatis utrinque planis vel minute prominulis nervo marginali conjunctis, venulis immersis obscuris; floribus ♂ 5–16 per inflorescentiam sub anthesi 7–8 mm. diametro ex pulvinis conspicuis (3–5 mm. diametro) in axillis foliorum saepe delapsorum orientibus, bracteis minutis numerosis suffultis; pedicellis sub anthesi 5–8 mm. longis gracilibus (0.3–0.5 mm. diametro); sepalis 4 papyraceis vel submembranaceis, oblongis vel obovato-oblongis, apice rotundatis, margine integris, 2 exterioribus valde concavis circiter 2.5 mm. longis et latis, 2 interioribus tenuioribus, 3.5–4 mm. longis, circiter 3 mm. latis; petalis 4 sub anthesi erecto-patentibus tenuiter carnosus elliptico- vel obovato-oblongis, 4.5–5 mm. longis, circiter 3 mm. latis, rotundatis, integris; phalangibus 4 carnosis 2.5–3 mm. longis copiose ramulosis, basi connatis; staminibus apicem phalangis versus aggregatis 30–35 per phalangem, antheris subsessilibus subpeltatis carnosus 0.5–0.6 mm. diametro, loculis plerumque 4 rimis distinctis parvis horizontalibus apicali-lateralibus dehiscentibus; rudimento gynaecii nullo vel minute pulvinato.

NETHERLANDS NEW GUINEA: Bernhard Camp, Idenburg River, alt. 100 m., *Brass & Versteegh 13570* (TYPE), April 15, 1939 (tree 33 m. high, frequent in primary rain-forest on the lower mountain-slopes, the trunk 62 cm. diam., the crown not wide-spreading, the bark 5 mm. thick, brown, scaly, with some dark yellow latex, the wood brown; flowers white).

Garcinia idenburgensis seems related to *G. Pullei* Lauterb., from which it differs in its thicker and larger leaf-blades with less obvious venation, larger flowers, and anthers with fewer locules (those of *G. Pullei* having 10–20 locules). The flowers of *G. idenburgensis* are more numerous and smaller than those of the preceding two new species, while the phalanges are clearly four.

***Garcinia platyphylla* sp. nov.**

Arbor glabra ad 20 m. alta, ramulis crassis fuscis apicem versus complanatis inferne subteretibus; petiolis rugosis semiteretibus 2–3 mm. crassis 7–17 mm. longis, basi foveola conspicua coriacea margine ad 3 mm. incrassata praeditis; laminis tenuiter coriaceis late ellipticis vel obovato-ellipticis, 10–20 cm. longis, 6–14.5 cm. latis, basi obtusis et petiolum paullo decurrentibus, apice obtusis vel rotundatis, margine integris et paullo recurvatis, costa valida supra paullo elevata et striata subtus prominente, nervis lateralibus numerosissimis (1–3 mm. distantibus rete venularum irregulariter conjunctis) erecto-patentibus rectis utrinque prominulis nervo marginali conjunctis, venulis indistincte prominulis; inflorescentiis ♂ cymosis terminalibus ut videtur 10–20-floris (sed floribus ante anthesi saepe delapsis) 3–5 cm. longis et latis, pedunculo brevi et ramulis paucis crassis, bracteis coriaceis concavis ovato-deltaideis subacutis 2–4 mm. longis; floribus apice ramulorum inflorescentiarum binis vel ternatis, pedicellis ad 5 mm. longis apice bibracteolatis et articulatis; sepalis 4 imbricatis papyraceis concavis semiorbicularibus integris, 2 exterioribus circiter 3 mm. longis et 4.5 mm. latis, 2 interioribus circiter 4 mm. longis et 6 mm. latis; petalis 5 (immaturis) carnosis oblongo-obovatis, alabastro circiter 5 mm. longis et 4 mm. latis, rotundatis, integris; toro androecii carnoso subcupuliformi margine elevato, staminibus 40–50 apicem tori versus congestis, antheris subsessilibus immaturis ut videtur obovoideo-oblongis (0.5–0.8 mm. longis) 2 (vel 3–4?)-loculatis, rimis longitudinalibus lateralibus dehiscentibus (?); rudimento gynaecii circiter 1.3 mm. longo, stipite carnoso, stigmate circiter 0.6 mm. diametro minute ruguloso; fructibus (inflorescentiis fructiferis non visis) elongato-ovoideis, ad 5.5 cm. longis et 2.5 cm. latis, basi inconspicue stipitatis et sepalis persistentibus suffultis,

apicem versus gradatim attenuatis, apice ipso obtusis et stigmate sessili 4–5 mm. diametro bilobato ruguloso coronatis, extra levibus, pericarpio siccitate coriaceo 0.5–1 mm. crasso, seminibus 2 elongato-ovoideis rugulosis, dissepimento membranaceo, pulpo ut videtur sparso.

SOLOMON ISLANDS: Bougainville: Siwai, *Waterhouse 108* (NY, TYPE, Y), Oct. 1932 (tree 8–9 m. high; native name: *matumatu*); Koniguru, Buin, alt. 900 m., *Kajewski 2016* (tree up to 20 m. high, common in rain-forest; native name: *nakamolo*).

The type collection bears immature staminate flowers, the Kajewski specimen being accompanied by detached fruits. As these two specimens are nearly identical in the details of their foliage, I have little hesitation in referring them to the same species, although the fruit of the second is not of the type commonly found in *Garcinia*. Comparison with other species of the region leaves little doubt that a new species is represented, but it seems inadvisable at present to refer it to a section. The flowers, unfortunately, are not sufficiently mature to permit the structure of the anthers to be entirely understood; it seems probable that a new section may eventually be desirable for this species. However, it is apparent that the anthers are subsessile on the margin of a continuous and somewhat cupuliform structure surrounding the gynaecium-rudiment. This arrangement is suggestive of § *Conocentrum*. The young anthers of our plant are crowded and appear to have three or four locules, but more mature anthers seem to be 2-loculed and longitudinally dehiscent, as in § *Cambogia*. The precise shape of the floral axis of the new species is not found in § *Cambogia*, which, furthermore, appears never to have only two cells in the ovary. *Garcinia platyphylla* is further characterized by its thick leaf-blades with numerous lateral nerves, its cymose inflorescences, and its 5 petals.

PENTAPHALANGIUM Warb.

Pentaphalangium latissimum (Miq.) Lauterb. Bot. Jahrb. 58: 46. 1922.

Garcinia latissima Miq. Ann. Mus. Bot. Lugd.-Bat. 1: 209. 1864; Pierre, Fl. Forest. Cochinch. 2: XXXVI. 1883; Vesque in DC. Monogr. Phan. 8: 338. 1893.

NETHERLANDS NEW GUINEA: 2 km. southwest of Bernhard Camp, Idenburg River, alt. 800 m., *Brass & Versteegh 13196* (tree 25 m. high, frequent in primary rain-forest on the slope of a ridge, the trunk 56 cm. diam., the crown not wide-spreading, the bark 17 mm. thick, black, scaly, with a fair amount of light yellow latex, the wood yellow-brown; fruits green).

The species was based on a specimen collected in Halmahera by Teysmann and subsequently cultivated at Buitenzorg; a sterile specimen from this cultivated plant (no. VI, c, 28) is available in the herbarium of the New York Botanical Garden. Although the species is included by Lauterbach in his treatment of the New Guinea Guttiferae, his description and his new combination are apparently based entirely on a staminate specimen from the Buitenzorg plant. It seems, therefore, that the collection by Brass & Versteegh is the first of the species from New Guinea. Our specimen has foliage which is an excellent match for that of the Buitenzorg plant, and its fruits agree very well with those described by Pierre and Vesque.

***Pentaphalangium pachycarpum* sp. nov.**

Arbor glabra ad 24 m. alta, ramulis crassis apicem versus 4–8 mm. diametro subteretibus rugosis fusco-cinereis, novellis in nodis paullo applanatis; petiolis validis rugosis circiter 3 mm. diametro leviter canaliculata 15–32 mm. longis, basi foveola elliptica margine valde coriacea et elevata praeditis; laminis coriaceis siccitate fuscis obovato- vel oblongo-ellipticis, 9–22 cm. longis, 5.5–11.5 cm. latis, basi subacutis vel attenuatis et in petiolum decurrentibus, apice rotundatis interdum emarginatis, margine integris et anguste recurvatis, costa valida supra conspicue elevata subtus prominente carinata, nervis secundariis utrinsecus numerosis (1–3 mm. distantibus, alternatis debilioribus) patentibus nonnunquam furcatis utrinque prominulis vel supra subimmersis nervo marginali inconspicuo conjunctis, venulis immersis; inflorescentiis ♀ terminalibus crassis ad 3 cm. longis breviter spicatis 3–7-floris, pedunculo brevi et rhachi rugosis subteretibus 5–6 mm. crassis, floribus sessilibus bracteis papyraceis deltoideo-suborbicularibus rotundatis integris circiter 2 mm. longis et 4–5 mm. latis subtentis; sepalis 3 vel 4 imbricatis tenuiter coriaceis semiorbicularibus, circiter 4 mm. longis, 6–8 mm. latis, apice rotundatis, margine anguste scariosis et integris; petalis 5 vel 6 papyraceis obovato-oblongis, 10–11 mm. longis, 8–10 mm. latis, apice rotundatis, basim versus angustatis, margine scariosis et integris saepe inflexis; phalangibus 5 vel 6 trienti inferiori petalorum adnatis inconspicuis 2–3 mm. longis irregulariter divisis ut videtur interdum nullis; ovario breviter cylindrico rugoso sub anthesi 4–5 mm. diametro, stigmate carnosio circiter 5 mm. diametro obscure et regulariter ruguloso, loculis 2 uniovulatis; fructibus elongato-ovoideis, maturitate ad 10 cm. longis et 4.5 cm. latis, basi rotundatis et sepalis persistentibus suffultis, apice stigmate conspicuo ad 1 cm. diametro coronatis, pericarpio siccitate crasse coriaceo (lignoso?) 4–7 mm. crasso utrinque sublevi, semini-

bus 2 lanceolato-ovoideis, ad 8 cm. longis et 2 cm. latis, siccitate coriaceis, apicem versus angustatis, extra conspicue impresso-reticulatis.

NETHERLANDS NEW GUINEA: Bernhard Camp, Idenburg River, alt. 50–100 m., *Brass & Versteegh 13550* (TYPE), April 10, 1939 (tree 24 m. high, occasional in primary rain-forest on lower mountain-slopes, the trunk 72 cm. diam., the crown fairly wide-spreading, the bark 10 mm. thick, black, scaly, with some white latex, the wood yellow-brown; flowers white; young fruits green, the ripe ones red), *Brass 14065* (tree about 20 m. high, common in flooded rain-forest of river-plain; fruits green).

The position of this plant in *Pentaphalangium* is indicated by the leaf-texture, fruit-shape (suggesting that of *P. carolinense* Lauterb.), and position of the flowers, as well as by the presence of staminodial phalanges on the petals of the pistillate flowers. On the type-specimen very few flowers are available, and the above description, based only on two dissections, may require future amplification; no. 14065 bears only foliage and fruits. Of the two flowers dissected, one has six petals with obvious but not conspicuous phalanges, while the other, curiously, has five entirely smooth petals.

From its only close ally, *P. latissimum* (Miq.) Lauterb., the new species differs in its somewhat smaller leaves, proportionately broader sepals and petals, and much longer and proportionately narrower fruits.

***Pentaphalangium Brassii* sp. nov.**

Arbor glabra ad 20 m. alta, ramulis crassis apicem versus 4–8 mm. diametro valde rugosis, novellis complanatis vel leviter quadrangulatis demum subteretibus; petiolis rugosis 2–4 mm. crassis canaliculatis 10–25 mm. longis, basi foveola elliptica margine valde crassa et elevata praeditis; laminis subcoriaceis oblongo-ellipticis, 13–32 cm. longis, 6–16 cm. latis, basi acutis vel attenuatis et in petiolum decurrentibus, apice rotundatis vel leviter emarginatis, margine integris et paullo recurvatis, costa valida supra elevata subtus prominente, nervis lateralibus utrinsecus numerosis (1–3 mm. distantibus, alternatis debilioribus) rectis plerumque simplicibus utrinque prominulis nervo marginali conjunctis, rete venularum inconspicuo vel in laminis novellis leviter prominulo; inflorescentiis ♀ terminalibus crassis 1.5–2.5 cm. longis cymosis vel breviter spicatis 3–7-floris, pedunculo brevi rugoso 3–4 mm. crasso, bracteis basi ramulorum inconspicuum oblongis acutis ad 8 mm. longis; floribus sessilibus sub anthesi 22–25 mm. diametro, bracteis papyraceis deltoideis acutis carinatis 3–4 mm. longis subtentis; sepalis 4 coriaceis imbricatis late ovato-semiorbicularibus, 4–6 mm. longis, 7–8 mm. latis,

rotundatis, margine scariosis et integris; petalis 5 papyraceis obovato-oblongis, 13–14 mm. longis, 8–9 mm. latis, basim versus angustatis, margine integris vel obscure erosulis, venulis distaliter inconspicue reticulatis; phalangibus inconspicuis 1.5–2 mm. longis pauciramosis basi petalorum adnatis; ovario breviter subcylindrico sulcato sub anthesi 3–5 mm. diametro apicem versus obscure ruguloso, stigmatibus conspicuo carnosio convexo 6–7 mm. diametro minute ruguloso, loculis 3 uniovulatis; fructibus ovoideis, maturitate ad 9 cm. longis et 5 cm. latis, basi rotundatis et sepalis persistentibus suffultis, apice stigmatibus ad 1 cm. diametro coronatis, pericarpio coriaceo siccitate 2–5 mm. crasso utrinque sublevi, dissepimentis subcoriaceis, seminibus 3 (interdum 1 vel 2) oblongo-ovoides, ad 7 cm. longis et 3 cm. latis, siccitate valde coriaceis, apicem versus gradatim angustatis, testa subcoriacea inconspicue impresso-reticulata.

BRITISH NEW GUINEA: Lower Fly River, east bank opposite Sturt Island, *Brass* 8206 (TYPE), Oct. 1936 (dense-foliaged tree 20 m. high, common on banks of river in flood-plain rain-forest, the trunk cylindric, the bark dark, rough, fissured, the latex cream colored, the branches short and weak; flowers white, the stigma yellow; ripe fruit red).

Pentaphalangium Brassii bears a close resemblance to the preceding new species (*P. pachycarpum*), but differs in its slightly more slender pistillate inflorescence with acute and carinate rather than rounded bracts, in its longer and proportionately narrower petals with the staminodial phalanges at the base rather than higher on the face of the petal, in its 3 rather than 2 ovary-locules, in the thinner pericarp of its fruit, and in its proportionately broader seeds with less obvious surface reticulation. The flowers dissected all agree in having 4 sepals, 5 petals, and 3 ovary-locules, but of course additional material may prove these numbers unstable.

***Pentaphalangium solomonense* sp. nov.**

Arbor glabra 10 m. alta, ramulis fuscis apicem versus subcomplanatis et 3–4 mm. crassis demum subteretibus rugosis lenticellatis; petiolis rugosis semiteretibus circiter 2 mm. crassis 10–15 mm. longis, basi foveola elliptica margine coriacea et valde (ad 2 mm.) elevata praeditis; laminis crasse coriaceis siccitate fuscis obovato-ellipticis, 7–13.5 cm. longis, 3.5–7 cm. latis, basi subattenuatis et in petiolum decurrentibus, apice rotundatis vel inconspicue emarginatis, margine integris et leviter recurvatis, costa supra subplana vel paullo elevata subtus prominente carinata, nervis secundariis utrinsecus numerosis (1–1.5 mm. distantibus) erecto-patentibus utrinque prominulis vel supra subimmersis mar-

ginem versus saepe furcatis nervo marginali conjunctis, rete venularum subtus interdum leviter prominulo; inflorescentiis ♀ terminalibus ad 3 cm. longis trichotome cymosis (3-)9-15-floris (sub anthesi floribus paucis), pedunculo brevi et ramulis paucis rugosis 2-3 mm. crassis saepe leviter angulatis, bracteis basi ramulorum coriaceis oblongis subacutis 4-7 mm. longis, floribus sessilibus bracteis coriaceis deltoideo-semi-orbicularibus rotundatis circiter 2 mm. longis et 3-4 mm. latis subtentis; sepalis 4 late imbricatis coriaceis concavis semiorbicularibus, 3.5-5 mm. longis, 5-6 mm. latis, rotundatis, margine scariosis et integris; petalis 5 (raro 4) carnosis obovato-oblongis (in specimine nostro immaturis), 6-7 mm. longis, 3-4 mm. latis, apice rotundatis, basim versus angustatis, margine integris; phalangibus trienti inferiori petalorum adnatis inconspicuis simplicibus stamina 1-3 sterilia gerentibus (filamentis carnosis circiter 0.2 mm. longis, antheris subglobosis vel transverse ellipsoideis 0.5-0.8 mm. diametro); ovario obovoideo-cylindrico ante anthesim 2-3 mm. diametro sulcato carnosio, stigmate conspicue ruguloso circiter 2.5 mm. diametro margine irregulariter lobulato, loculis 2 uniovulatis; fructibus juvenilibus elliptico-subglobosis, basi rotundatis et sepalis persistentibus suffultis, apice stigmate bilobato ruguloso ad 3.5 mm. diametro coronatis, pericarpio coriaceo.

SOLOMON ISLANDS: N'Gela Group (Florida Islands), Olevugā: Brass 3484 (TYPE), Jan. 16, 1933 (tree 10 m. high, solitary in a rain-forest gully on grassland, the branches stiffly spreading, the bark hard, rough, dark brown, with a white sticky latex, the leaf-blades stiff, with pale midribs; immature fruits pale yellow, with black persistent stigmas).

Compared with the species thus far known in *Pentaphalangium*, *P. solomonense* is unusual in having the staminodial phalanges of the petals of its pistillate flowers composed of 1-3 abortive stamens; as a rule these phalanges are merely irregularly laciniated tissue with no approximation of true anthers. Conspicuously different from the Papuan species thus far known, *P. solomonense* seems most closely related to *P. carolinense* Lauterb., from which it differs in its much thicker leaf-texture; in *P. carolinense* the phalanges of the pistillate flowers have numerous branches (Kanehira, Fl. Micrones. 241. fig. 112, C. 1933).

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PLANTAE PAPUANAE ARCHBOLDIANAE, VII*

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THIS paper is a continuation of our study of the smaller families of the Papuan collections. Lack of authentic material for comparison, coupled with the fluidity of generic lines, has made the identification of the Vitaceae a particularly difficult task. The family is in great need of critical revision, and, in order to clear up some of the loose concepts, it should be surveyed as a whole rather than geographically.

VITACEAE

Ampelocissus Planchon

Ampelocissus acetosa Planchon, Vigne Améric. 96. 1885; Planchon in DC. Monog. Phan. 5: 381. 1887; Domin, Bibl. Bot. 22: 925. 1927.

Cissus acetosa F. v. Muell. Trans. Phil. Inst. Vict. 3: 24. 1859.

Vitis acetosa F. v. Muell. Pl. Vict. 1: 94. 1860-62; Benth. Fl. Austr. 1: 449. 1863; F. M. Bail. Queensl. Fl. 1: 282. 1899.

BRITISH NEW GUINEA: Western Division, Wassi Kussa River, Tarara, *Brass* 8647, January 1937, rambling amongst grass in savannah-forest (branches, petioles and lower surface of leaves glaucous; inflorescence red); Daru Island, *Brass* 6448, April 1936, rare small climber in edge of light rain-forest (large bunches of grape-like fruit); Laloki River, Haga, *Brass* 900, January 1926, coast savannahs (flowers reddish; fruit black, edible, slightly acrid).

With no available material for comparison, and with the similarity between the Papuan specimens and the description of this Queensland species so marked, we have hesitated to place these collections elsewhere at present. *Ampelocissus pauciflora* Merr. of the Philippine Islands is a closely related species.

Tetrastigma Planchon

Tetrastigma Pullei Lauterb. Bot. Jahrb. 59: 514. 1925.

NETHERLANDS NEW GUINEA: 9 km. northeast of Lake Habbema, *Brass* 10247A, October 1938, alt. 2800 m., common climber of second growths in forest openings.

*(Botanical Results of the Richard Archbold Expeditions) See Jour. Arnold Arb. 22: 254-270. 1941.

Although this collection seems to belong to *Tetrastigma Pullei* Lauterb., it seems worth mentioning that the leaves are coriaceous or very firmly chartaceous, the terminal leaflets vary from 1.7 to 4 cm. long and up to 3.2 cm. broad, the widely spreading primary veins are impressed above (sometimes also branched so that the upper leaf-surface appears rugose) and prominent beneath.

Tetrastigma Lauterbachianum Gilg in Engler & Prantl, Nat. Pflanzenfam. 3(5): 447, f. 218 A-E. 1896; K. Schum. & Lauterb. Fl. Deutsch. Schutzgeb. Südsee 430. 1900; Lauterb. Bot. Jahrb. 59: 510. 1925.

SOLOMON ISLANDS: Malaita Island, Quoiomonapu, *Kajewski* 2319, December 1930, common in rain-forest at sea level.

The species has been recorded previously from New Guinea and the Bismarck Archipelago.

Cissus Linnaeus

Cissus conchigera Ridley, Trans. Linn. Soc. Bot. II. 9: 31. 1916.

NETHERLANDS NEW GUINEA: 4 km. southwest of Bernhard Camp, Idenburg River, *Brass* 13075, March 1939, alt. 850 m., climbing in *Saccharum* on flood banks of river (flowers greenish yellow; fruit black). BRITISH NEW GUINEA: Palmer River, 1 mile above Black River Junction, *Brass* 6942, June 1936, wet clayey soil on riverside landslip (low scrambling brown-pubescent shrub; flowers yellow); Lake Daviumbu, Middle Fly River, *Brass* 7479, rain-forest, very common large canopy liana.

Without access to the type-specimens, we are unable to distinguish *Cissus Ledermannii* Lauterb. from this species. The lower leaf-surfaces in the Fly River collections are much more pubescent than those of the collection from Netherlands New Guinea, but all surely belong to the same species.

Cissus indica Rottler, Ges. Naturf. Freund. Berl. Neu. Schrift. 4: 183. 1803.

Cissus adnata Roxb. Fl. Ind. 1: 423. 1820.

On account of some doubt as to the identity of the plant, the name *Cissus indica* Rottler was discarded by Planchon. There seems to be, however, an authentic specimen in Willdenow's herbarium, and, in the light of the numerous present day collections, this ought to be re-examined together with the originals of *C. adnata* Roxb. and *C. assamica* (Laws.) Craib. These species have been variously interpreted. Of

the Indo-Malaysian material at hand, all of the earlier Indian collections have been distributed under the specific name *adnata*. In this are three entities as to types of pubescence: (1) pubescence of single several-celled hairs; (2) pubescence of malpighioid hairs, the leaf tending to become glabrous except along the nerves on the lower surface; (3) pubescence of malpighioid hairs, the leaf tending to remain densely pubescent on the lower surface. In addition, in the flowers of plants clothed with simple hairs, there are a few hairs around the base of the style on the disk; in the other two, the disk of the flowers is glabrous. The first, Gagnepain, Not. Syst. 1: 353. 1911, has interpreted as *C. adnata* Roxb., a species unquestionably distinct from the other two entities designated as *C. assamica* (Laws.) Craib, and var. *pilosissima* Gagnep. respectively. Whether Gagnepain's interpretation is correct we cannot say, since he gives no indication of having had access to authentic material of *C. adnata* Roxb. and both species are reported from the same region. As a matter of fact, in the early and historic collections (some of which are cited by Gagnepain) at hand the material is badly mixed; hence, without the opportunity to examine the original specimens, and, considering the rather vague original descriptions, any decision in the matter must, of necessity, be arbitrary.

In the Papuan collections under consideration there are specimens which, we believe, represent both *C. adnata* Roxb. and *C. assamica* (Laws.) Craib as interpreted by Gagnepain. Of the former, we have a single specimen, *Schlechter 18896*, cited by Lauterbach, Bot. Jahrb. 59: 519. 1925, under *C. repens* Lam. Unfortunately, we have not a single collection cited by Lauterbach under *C. adnata* Roxb.; hence, we are at a loss to know what entity he considered to be *C. adnata* Roxb. Further, we do not find in his work, "Die Vitaceen Papuasiens," any mention of *Hollrung 419*, the one collection of this complex from New Guinea cited by Gagnepain. In view of the nomenclatural dilemma outlined above, for the present we have assigned the following collections to:

***Cissus assamica* (Laws.) Craib, Kew Bull. 1911: 31. 1911.**

Vitis assamica Laws. Fl. Brit. Ind. 1: 648. 1875.

NETHERLANDS NEW GUINEA: 15 km. southwest of Bernhard Camp, Idenburg River, *Brass 12397*, January 1939, alt. 1500 m., rain-forest, climbing in undergrowth on open bank of stream (flowers yellow; fruit immature); 4 km. southwest of Bernhard Camp, Idenburg River, *Brass 13064*, March 1939, alt. 850 m., in rain-forest seral growths, common scrambling shrub on river banks. BRITISH NEW GUINEA:

Jawarere, *Brass* 679, November 1925, alt. \pm 300 m., rain-forest. NORTHEASTERN NEW GUINEA: Bulung River, *Clemens* 5341, February 1937, alt. \pm 800 m. SOLOMON ISLANDS: Bougainville Island, without definite locality, *Kajewski* 1605, March 1930, alt. 100 m., rain-forest (fruit black when ripe, 6 mm. long, 7 mm. diameter); Kugimaru, Buin, *Kajewski* 1811, June 1930, alt. 150 m., rain-forest (fruit shiny black when ripe, 6 mm. long 5.5 mm. diameter); Marmaromino, *Kajewski* 2215, September 1930, alt. 50 m., climbing in rain-forest trees.

Somewhat doubtfully we add *Kajewski* 2410, Berande, Guadalcanal Island. The leaves of this are larger and more membranaceous than in the other collections cited.

Cissus simplex Blanco Fl. Filip. 72. 1837; Merr. Enum. Philip. Fl. Pl. 3: 7. 1923.

Cissus pyrrhodasys Miq. Fl. Ind. Bat. Suppl. 1: 517. 1860.

SOLOMON ISLANDS: Guadalcanal Island, Uulolo, Tutuve Mountain, *Kajewski* 2640, May 1931, alt. 1200 m., common in rain-forest; Malaita Island, Quoiomonapu, *Kajewski* 2362, December 1930, alt. 50 m., rain-forest.

These collections represent a small range extension eastward. The species is known from India through Malaysia. Possibly this is the entity which Lauterbach designated as *Cissus adnata* Roxb. var. *montana* in New Guinea.

Cissus* ? *hypoglauca A. Gray, Bot. U. S. Expl. Exped. 272. 1854; Planchon in DC. Monog. Phan. 5: 519. 1887.

Vitis hypoglauca F. v. Muell. Pl. Vict. 1: 94. t. 10. 1860-62; Benth. Fl. Austral. 1: 450. 1863.

NORTHEASTERN NEW GUINEA: Ogeramnang, *Clemens* 4970, January 1937, alt. \pm 1700 m., tall vine in forest.

This rather young specimen shows a very strong likeness to our Australian material of *Cissus hypoglauca* A. Gray. It differs in that the midrib on the lower surface of the leaflets, the petioles, petiolules, and the axis of the inflorescence are clothed more or less with a brownish tomentum. This is obviously partly deciduous, but whether it is wholly so as the plant arrives at maturity we cannot say.

***Cayratia* Jussieu**

Cayratia grandifolia (Warb.) comb. nov.

Cissus grandifolia Warb. Bot. Jahrb. 18: 199. 1893; K. Schum. & Lauterb. Fl. Deutsch. Schutzgeb. Südsee 428. 1900; Lauterb. Nov. Guin. 8: 302. 1910; Rechinger, Denkschr. Math.-Naturw. Kaiserl.

Akad. Wissensch. **89**: 574 (Bot. Zool. Ergeb. Wiss. Forsch. Samoa-I. Neug.-Arch. Salomonsins. **5**: 132). 1913; Ridl. Trans. Linn. Soc. Bot. II. **9**: 31. 1916; Lauterb. Bot. Jahrb. **59**: 527. 1925.

BRITISH NEW GUINEA: Western Division, Daru Island, *Brass* 6396, March 1936, rare in second growth rain-forest (robust liana); Sturt Island, Lower Fly River, *Brass* 8195, October 1936, rain-forest (large climber ascending to the tree-tops); Central Division, Nakeo District, Baroka, *Brass* 3771, April 1933, alt. 30 m., fairly common in the rain-forests (very large climber with thick flexible stems; leaflets somewhat convex, shining on both surfaces, nerves pale; petals greenish yellow). SOLOMON ISLANDS: Bougainville Island, Kieta, *Kajewski* 1577, March 1930, at sea-level, rain-forest (common vine; fruit white-green when ripe, semi-transparent, flattened at the apex and the base, 9 mm. long, 14 mm. diameter, when dry 6 mm. long, 8 mm. diameter, \pm rugose).

Although we have no authentic material for comparison, these collections agree reasonably well with the description of this species except that the pubescence on the lower surface of the leaves is confined to the midrib and the larger nerves.

Cayratia megacarpa (Lauterb.) comb. nov.

Cissus megacarpa Lauterb. Bot. Jahrb. **59**: 526. 1925.

This species is represented in our herbarium only by *Schlechter* 16878, a specimen cited in the original description.

Cayratia lineata (Warb.) comb. nov.

Cissus lineata Warb. Bot. Jahrb. **13**: 370. 1891.

Cayratia lineata* var. *fusco-lanata (Lauterb.) comb. nov.

Cissus lineata var. *fusco-lanata* Lauterb. Bot. Jahrb. **59**: 528. 1925;
C. T. White, Jour. Arnold Arb. **10**: 236. 1929.

The two specimens of this variety at hand are *Schlechter* 16775, an isotype, and *Brass* 1137.

Cayratia japonica (Thunb.) Gagnep. Not. Syst. **1**: 349. 1911, Fl. Gén. Indo-Chine **1**: 983. t.26. f.11-16. 1912.

Vitis japonica Thunb. Fl. Japan 104. 1784.

SOLOMON ISLANDS: Guadalcanal Island, Uulolo, Tutuve Mountain, *Kajewski* 2600, April 1931, alt. 1200 m., common in rain-forest (fruit black when ripe, flattened, 8 mm. long, 1.4 cm. diameter).

This collection agrees reasonably well with the material of this species from tropical Asia. *Cayratia japonica* (Thunb.) Gagnep. appears to be a wide-spread species, having been reported from China, Indo-China, Japan, Formosa, Java, the Philippines, Australia, New Caledonia, the

Loyalty Islands, and the Bismarck Archipelago. This seems to be the first record from the Solomon Islands.

Leea Linnaeus

Leea indica (Burm. f.) Merr. Philip. Jour. Sci. 14: 245. 1919, Enum. Philip. Fl. Pl. 3: 11. 1923.

Staphylea indica Burm. f. Fl. Ind. 75. t. 23, f. 2. 1768.

Leea sambucina Willd. Sp. Pl. 1: 1177. 1797; Benth. in Hook. Lond. Jour. Bot. 2: 214. 1843; Hemsl. Kew Bull. 1895: 134. 1895; Valetton, Bull. Dept. Agric. Néerl. 10: 31. 1907; Rechingen, Denkschr. Math.-Naturw. Kaiserl. Akad. Wissensch. 89: 574. 1913; C. T. White, Proc. Roy. Soc. Queensl. 34: 43. 1923; Lauterb. Bot. Jahrb. 59: 531. 1925; Lam, Nat. Tijdschr. Nederl. Ind. 88: 208. 1928; C. T. White, Jour. Arnold Arb. 10: 237. 1929.

BRITISH NEW GUINEA: Fly River, 528 mile Camp, *Brass* 6809, common on river banks from camp to coast; Lower Fly River, east bank opposite Sturt Island, *Brass* 8201A, plentiful on river banks (sparsely branched tree 6-7 m. high; stem and branches hollow and inhabited by ants; branchlets corrugated; flowers green).

In addition to the above are two other collections which may possibly belong here; at least without further material we are hesitant about placing them elsewhere at present. The leaves are very much like those of *L. indica* (Burm. f.) Merr. but are minutely pilose on the nerves on the lower surface of the leaflets, and the leaflets have a very long acumen (up to 3 cm.); the inflorescence (in early anthesis) is very short (up to 12 cm. long) as compared to the usual form in this species.

NETHERLANDS NEW GUINEA: 6 km. southwest of Bernhard Camp, Idenburg River, *Brass* 12764, February 1939, alt. 1200 m., on open banks of a small stream (tree 3 m. high). SOLOMON ISLANDS: San Cristobal Island, Waimamura, *Brass* 2591, August 1932, common in lowland rain-forests (sparsely branched tree 12 m. tall, supported on stilt roots 1 m. long; stems pithy; bark brown, lenticellate; flowers yellowish green; fruit compressed, fleshy, purple-black, 1.3 cm. diameter).

Leea solomonensis sp. nov.

Arbor usque 7 m. alta; ramulis minute ferrugineo-pubescentibus; foliis simpliciter pinnatis, in specimine typico 2-jugis; petiolo circiter 6 cm. longo et rhachi 7 cm. longa minute crispule ferrugineo-pubescentibus; foliolis ellipticis, \pm 18 cm. longis, 8-10 cm. latis, basi obtusis vel late cuneatis, apice fractis, margine repando-dentatis, chartaceis, supra glabris, subtus parce crispule pubescentibus, subclathrato-reticulatis, venis primariis utrinsecus 15-17, patenti-adscendentibus prope marginem

arcuatis, supra distinctis, subtus prominulis; petiolulis lateralibus 1.4–2 cm. longis, terminali 4.2 cm. longo; paniculis minute crispule pubescentibus, in fructu 35 cm. longis; alabastris immaturis, calyce puberulo; petalis 5 basi connatis, apice inflexo-mucronatis valvatis, 6 mm. longa, extus apicem versus puberulis; staminibus 5; ovario glabro, stylo glabro striato; baccis depressis globosis, in sicco \pm 1.5 cm. longis, 2.5 cm. diametro, 6-spermis.

SOLOMON ISLANDS: Guadalcanal Island, Ma-massa, Konga, *Kajewski* 2488 (TYPE), February 1931, alt. 400 m., common in rain-forest (a very small tree up to 7 m. high; fruit red when ripe, 2.4 cm. long, 3 cm. diameter, flattened at the apex and the base).

In its loosely branching inflorescence *Leea solomonensis* appears to be related to *L. macropus* Lauterb. & K. Schum. It may be readily distinguished however, by the elliptic leaves obtuse rather than rounded at the base, and the minute crisp pubescence on the lower surface of the leaves.

***Leea suaveolens* sp. nov.**

Arbor usque 10 m. alta; foliis simpliciter pinnatis, ? bijugis, petiolo \pm 7 cm. longo, glabro vel puberulo; foliolis oblongo-ellipticis, 15–20 cm. longis, 7–9 cm. latis, basi subrotundatis paullo obliquis, apice acuminatis, acumine 2–2.5 cm. longo, margine grosse serrato-crenatis, subcoriaceis, glabris vel subtus costa atque axillis inter venas ac costam parce pubescentibus, tenuiter subclathrato-reticulatis, venis primariis utrinsecus 11–13, patenti-adscendentibus prope marginem arcuatis, in dentes marginis ipsius excurrentibus; petiolulis \pm 1.5 cm. longis, puberulis interdum consperse glandulosis; paniculis puberulis subdivaricatum ramosis; floribus pentameris ad apices ramulorum 2–4-natis; pedicellis 5–6 mm. longis; calyce 3 mm. longo, campanulato, \pm irregulariter lobato, extus puberulo interdum parce glanduloso; corolla 7 mm. longa, laciniis oblongis, 4.5 mm. longis, apice brevissime subcucullatis inflexo-mucronulatis, extus puberulis; staminibus 5, filamentis prope basim disci extus insertis atque in sulcis longitudinalibus disci immersis, antheris in alabastro intra discum inflexis, 1.8 mm. longis; disco cylindrico, 5 mm. longo, 5-dentato, dentibus emarginatis; ovario glabro, 1 mm. longo, stylo striato 3 mm. longo puberulo; baccis globosis, siccis 2.5 cm. diametro, 6-spermis.

SOLOMON ISLANDS: Ysabel Island, Tiratona, *Brass* 3343 (TYPE), December 1932, alt. 600 m., common in rain-forests (densely foliaged tree up to 10 m. tall; leaves pale below; flowers cream-colored, sweetly perfumed; fruit globose, smooth, brown, up to 5 cm. diameter).

In the oblong-elliptic leaflets and the open inflorescence *Leea suaveolens* shows some resemblance to *L. macropus* Lauterb. & K. Schum. The latter, however, is a glabrous tree with flowers densely crowded at the apices of the ultimate branches of the inflorescence. In *L. suaveolens* the inflorescence is puberulous with scattered glands on the calyx and occasionally on the axis and the branches of the inflorescence; glands also occur on the rachis and the petiolules of the leaflets. Unfortunately, our material is too scanty to determine whether these are sufficiently constant to be used as a specific diagnostic character. The fruit of this species is somewhat larger than that reported for the other related species.

Leea macropus Lauterb. & K. Schum. Notizbl. Bot. Gart. Berl. **2**: 130. 1898; K. Schum. & Lauterb. Fl. Deutsch. Schutzgeb. Südsee 430. 1900, Nachtr. 313. 1905; Valeton, Ic. Bogor. **3**: 147. *t.* 258. 1908; Bak. f. Jour. Bot. **61**: Suppl. 11. 1923, l. c. **62**: 54. 1924; Lauterb. Bot. Jahrb. **59**: 530. 1925; Kaneh. & Hatus. Bot. Mag. Tokyo **52**: 415. 1938.

SOLOMON ISLANDS: San Cristobal, Balego-Nagonago, *Brass* 2825, September 1932, alt. 500 m., mountain rain-forests (sparsely branched spreading tree 6 m. tall; branches pithy, rather fleshy; leaves smooth and shining; flower buds yellow; unripe fruit brown, broadly pyriform, 2.5 cm. diameter).

Although we have no authentic material of this species for comparison, this collection corresponds too closely with Valeton's description and plate of K. Schumann's species to be placed elsewhere at present. Closely allied or possibly belonging to the same species is *Kajewski* 1865, a fruiting specimen with open inflorescence and bipinnate leaves. This material was collected on Bougainville Island.

Leea papuana sp. nov.

Arbuscula 2–2.5 m. alta, ramosa vel eramosa; foliis paucis sub apice caulis congestis, simpliciter pinnatis, 5-jugis; petiolo 17 cm. longo, rhachi 31 cm. longa 4-angulatis, supra canaliculatis, marginibus ventralibus alatis vel subalatis, glabris; petiolulis 6–12 mm. longis, crispo-alatis; foliolis anguste oblongis, 18–38 cm. longis, 6.5–10 cm. latis, basi obtusis vel subrotundatis, apice longe acuminatis, acumine 1.5–3 cm. longo, margine remotiuscule sinuato-dentatis, glabris, coriaceis, crebre clathrato-reticulatis, venis primariis utrinsecus 10–17, supra distincte manifestis, subtus perspicuis; panícula terminali conferta; axi 5–6 cm. longa; baccis brunneis globosis, \pm 3.5 cm. diametro, 6-spermis.

BRITISH NEW GUINEA: Palmer River, 2 miles below Black River

Junction, *Brass* 7325 (TYPE), July 1936, alt. 100 m., restricted to the muddy banks of flood-plain streams; uncommon (small tree, branched or unbranched, 2–2.5 m. high; leaves few, clustered at the apex of the stem below a dense terminal cluster of soft brown globose fruit \pm 3.5 cm. diameter).

Leea tuberculata Lauterb., *L. coryphantha* Lauterb., and *L. heterodoxa* Lauterb. & K. Schum., all have more or less the aspect of *L. papuana*. Nevertheless, our new species may be distinguished from the first by its simply pinnate leaves, from the second by the coriaceous narrower and sinuate-dentate leaflets, and from *L. heterodoxa* Lauterb. & K. Schum. by the narrowly winged rachis.

CAMPANULACEAE

Wahlenbergia Schrader

Wahlenbergia confusa sp. nov.

Herba gracilis glabra; caulibus decumbentibus hinc inde ramosis; ramis 5–15 cm. longis, adscendentibus, saepe confertis, inferne foliosis, insuper nudis (1–6 cm.), unifloris; foliis alternis, sessilibus, lineari-oblongis vel fere lanceolatis, 4–7 mm. longis, 1.5–2 mm. latis, remote minuteque serrato-dentatis; calyce glabro, tubo circiter 2 mm. longo, cyathiformi, lobis lineari-lanceolatis acuminatis, 3 mm. longis; corolla cyanea, 1.6 cm. longa, infundibuliformi, 5-fida, lobis ovatis; staminibus in alabastris prope anthesim 5 mm. longis, antheris 2 mm. longis, filamentis post anthesim 3 mm. longis, minute pilosis, basi applanatis sursum gradatim angustatis, versus apicem filiformibus; stylo longitudine tubi corollae, a medio ad apicem puberulo; stigmatibus 3, post anthesim revolutis; capsulis \pm 5 mm. diametro, subglobosis, calycis lobis reflexis coronatis, 3-locularibus, apice 3-valvis, dehiscentibus; seminibus ellipsoideis, vix 1 mm. longis.

NETHERLANDS NEW GUINEA: 5 miles northeast of Wilhelmina-top, *Brass* 9399 (TYPE), August 1938, alt. 3440 m., plentiful under the banks of grassland streams (ascending herb with striking blue flowers); 11 km. northeast of Wilhelmina-top, *Brass & Myer-Drees* 9721, September 1938, alt. 3400 m., rather wet open places along a small river (herbaceous; corolla blue).

The species most closely approaches the description of *Wahlenbergia eurycarpa* Domin, but that is an erect plant with a larger capsule. As compared with *W. gracilis* A. DC., this plant is readily separated by the one-flowered inflorescence, and the flowers are distinguishable by the outline of the filaments; in this species the filament gradually tapers

to a filiform apex, in *W. gracilis* A. DC. the flattened and pubescent base of the filament very abruptly narrows into the short filiform apex; the capsules too are slightly different in outline, and the calyx lobes crowning the capsule of *W. gracilis* A. DC. are erect.

Wahlenbergia gracilis A. DC. Monog. Campan. 142. 1830; F. v. Muell. Pap. Pl. 2: 11. 1885; K. Schum. & Lauterb. Fl. Deutsch. Schutzgeb. Südsee 593. 1900; White & Francis, Proc. Roy. Soc. Queensl. 38: 260. 1927.

NETHERLANDS NEW GUINEA: Balim River, *Brass* 11627, December 1938, alt. 1600 m., plentiful on grassy deforested slopes. BRITISH NEW GUINEA: Central Division, Wharton Range, Murray Pass, *Brass* 4640, June-September 1933, alt. 2840 m., sporadic on grasslands.

We believe these collections represent *Wahlenbergia gracilis* A. DC. in the wider sense. They appear to be more like the Australian material passing as *W. gracilis* A. DC. than the Asiatic material labelled *W. marginata* A. DC. It is to be noted, however, that there has been a tendency to regard the two as the same species, although specialists working on the group state very definitely that the Australian material is different from the Asiatic. Nannfeldt, Act. Hort. Gothob. 5: 32. 1929 (Campanulaceae in H. Smith, Pl. Sinenses) indicated that N. E. Brown, Gard. Chron. 54: 316. 1913, discussed and defined *Wahlenbergia gracilis*, attributing the combination to Schrader who did not complete it, and pointing out that *W. gracilis* A. DC. is a mixture of at least a half dozen perfectly distinct species; also that the entities cannot be untangled without considerable study of the types.

Pentaphragma Wallich

Pentaphragma macrophyllum Oliver, Jour. Linn. Soc. Bot. 15: 29. 1875; F. v. Muell. Pap. Pl. 1: 28. 1876; Valetton, Bull. Dept. Agric. Néerl. Ind. 10: 68. 1907; Pulle, Nov. Guin. Bot. 8: 407. 1910, l. c. 691. 1912; Lam, Nat. Tijdschr. Nederl.-Ind. 88: 213, 218. 1928.

NETHERLANDS NEW GUINEA: 6 km. southwest of Bernhard Camp, Idenburg River, *Brass* 12904, alt. 1200 m., in sheltered gully in rain-forest; 4 km. southwest of Bernhard Camp, Idenburg River, *Brass* 13275, alt. 850 m., occasional on shady banks of rain-forest streams. BRITISH NEW GUINEA: Fly River, 528 mile Camp, *Brass* 6622, May 1936, alt. 80 m., casual in gullies of forest (a striking fleshy unbranched shrub \pm 1 m. high; leaves smooth and shining, nerves deeply impressed above, prominent below; sepals greenish white; petals yellow; fleshy white fruit containing very small brown seeds).

The collections from Netherlands New Guinea agree closely with the original description. These have a practically glabrous flower, somewhat pubescent at the base and also on the subtending bracts and along the axis of the inflorescence. The lower surface of the leaves is pubescent chiefly along the nerves. In the Fly River material, the calyx-tube is pubescent outside even when mature, the axis of the inflorescence and the floral bracts are densely so, and the entire lower surface of the leaves is sparsely pubescent. Possibly further collections will reveal other differences.

Lobelia Linnaeus

Lobelia brachyantha sp. nov.

Herba prostrata paullo ramosa, conperse pilosa, trichomatibus simplicibus pluricellularibus; caulibus gracillimis; foliis parvis, late reniformi-orbicularibus, 2.5–5 mm. longis, 3–7 mm. latis, petiolatis, petiolo \pm 2 mm. longo; margine undulato-dentatis, dentibus mucronulatis, supra conperse pilosis, subtus glabris; floribus axillaribus; pedunculis 4–5 mm. longis; hypanthio brevissimo, calycis lobis 2–2.5 mm. longis, lineari-lanceolatis obtusiusculis, margine utroque prope medio lobulum unum gerentibus; corolla purpurea, oblique subcampanulata, 3 mm. longa, tubo brevi intus maculato atque minute piloso, lobis extus pilosis, 3 anticis ovatis, 2 posticis paullo oblique lanceolatis; staminibus connatis, fere 3 mm. longis, filamentis glabris, antherarum tubo extus postico parce glanduloso, antheris 2 inferioribus minoribus apice setigeris, 3 superioribus apice nudis; capsulis vix 3 mm. longis, bivalvis; seminibus compressis ovoideis.

NETHERLANDS NEW GUINEA: Bele River, 18 km. northeast of Lake Habbema, *Brass* 11570 (TYPE), November 1938, alt. 2350 m., creeping on bare rock on a sparsely vegetated limestone precipice (flowers a very dark purple).

Lobelia brachyantha is a very small species with a *Pratia*-like habit belonging to the section *Hemipogon*. It differs from the description of *L. arjakensis* Gibbs in the very shallowly sinuate-dentate leaf-margins, the much smaller flowers and capsules, the very short hypanthium, and the minutely lobed or toothed calyx-lobes. The hairs of the pubescence are distinctly several-celled.

Lobelia microcarpa C. B. Clarke in Hook. f. Fl. Brit. Ind. 3: 424. 1881, *vel aff.*

BRITISH NEW GUINEA: Oriomo River, Wuroi, *Brass* 5737, January-March 1934, alt. 10–30 m., common throughout the savannahs (fleshy

ascending herb with small blue flowers); Lake Daviumbu, Middle Fly River, *Brass* 7839, plentiful on wet savannahs and open grass plains (flowers bright blue).

This plant (from 10–50 cm. in height) is much larger than that (7–13 cm.) which was the basis of the original description, yet the characters are similar: the lower leaves are lanceolate-ovate, crenulate-dentate, the upper are linear and bract-like. The seeds are distinctly trigonous. Unfortunately, we have no material for comparison. It is very much like some collections from Indo-China and China at present passing under various names, including material named by F. E. Wimmer as a variety of *L. alsinoides* Lam. and described by Danguy as *L. chinensis* Lour. var. *cantonensis* Wimm.

***Lobelia zeylanica* L. Sp. Pl. 932. 1753; G. Don, Gen. Syst. 3: 709. 1834.**

Lobelia succulenta Blume, Bijdr. 728. 1826; Lam, Nat. Tijdschr. Nederl. Ind. 89: 315, 317. 1929.

Lobelia affinis Wall. List no. 1311. 1829, *nomen nudum*; G. Don, Gen. Syst. 3: 709. 1834; S. Moore, Trans. Linn. Soc. Bot. II. 9: 88. 1916; Diels, Bot. Jahrb. 55: 122. 1917.

Lobelia barbata Warb. Bot. Jahrb. 13: 444. 1891; K. Schum. & Lauterb. Fl. Deutsch. Schutzgeb. Südsee 593. 1900.

NETHERLANDS NEW GUINEA: 4 km. southwest of Bernhard Camp, Idenburg River, *Brass* 13253, March 1939, alt. 850 m., rain-forest, common on open flood banks of river; Bernhard Camp, Idenburg River, *Brass* 13965, April 1939, alt. 55 m., on silt beds in a rain-forest stream (flowers violet). NORTHEASTERN NEW GUINEA: in open thickets, *Schlechter* 18258, September 1908, alt. 600 m.

Two factors probably have contributed to the confusion associated with the interpretation of *Lobelia zeylanica* L. Linnaeus derived his specific name from *Campanula ceylanica*, *senecionis folio*, *flore purpureo* Seba, Thes. 1: 37. t. 22, f. 12. 1734, yet, at the same time, adding a question mark to the reference; however, his description was based wholly on a plant collected by Osbeck, near Canton, China, and this, as described, represents a species totally different from the form Seba illustrated. The Osbeck specimen is unquestionably the type of *L. zeylanica* L. We have examined a number of collections from southern China which agree well with the description of Linnaeus' species, and some of these have been so named by F. E. Wimmer. In the herbarium of the New York Botanical Garden is a specimen named in Blume's handwriting as *L. succulenta* Bl., thus being apparently an isotype. It is a good match for the Chinese material of *L. zeylanica* L., and also for the Indian material of *L. affinis* Wall. It should be noted, however,

that De Candolle, Prodr. 7: 373. 1839, placed *L. succulenta* Bl. in §2, characterized thus, "Antherae 2 solum inferiores apice barbatae vel setis terminatae," and in his specific description says "Antherae superiores glabrae"; his authority for this is "(v. in h. mus. Par. a cl. Blum. miss.)." Hence, it would seem either that Blume distributed a mixed collection or that De Candolle erred in his observations. We have at hand collections of this species from China, India, Sumatra, Java, and New Guinea.

A collection from Java labeled in Blume's handwriting as *Lobelia javensis* Zipp. is a distinctly different species.

Phyllocharis Diels

Phyllocharis subcordata sp. nov.

Herba basi radicans; caulibus glabris; foliis 1–1.5 cm. petiolatis, tenuiter membranaceis, glabris vel subtus in nervis puberulis, anguste ovatis, 1.5–3.5 cm. longis, 1.2–2 cm. latis, apice acutiusculis, basi subcordatis vel truncato-subcordatis saepe paullo inaequilateralibus, margine crenato-dentatis, dentibus mucronatis; floribus pedunculatis; pedunculo 5–6 mm. longo; calycis tubo 1–2 mm. longo, glabro, lobis linearibus, 2–3 mm. longis; corollae tubo brevissimo, lobis 2 posticis 8 mm. longis, 0.5 mm. latis, quam labio antico subduplo longioribus, glabris, lobis 3 anticis 3 mm. longis supra medium connatis, intus papillosis; seminibus minute verruculosus.

NORTHEASTERN NEW GUINEA: Morobe District, Yoangen, *Clemens* 3426 (TYPE), June 1936, alt. \pm 1200 m., on wet bank with *Elatostemma* (flowers yellow); Malalo Mission, *Clemens* 4404A, December 1936, alt. \pm 750 m.

In the crenate-dentate leaf-margin and the inner papillose surface of the anterior lip of the corolla, this species approaches *Phyllocharis Schlechteri* Diels; in the practically glabrous flower, the much longer posterior lobes of the corolla and the verruculose seeds there is a likeness to *P. oblongifolia* Diels. *Phyllocharis subcordata* differs from both species in the subcordate or truncate and very shallowly lobed leaf-base.

GOODENIACEAE

Velleia Smith

Velleia spathulata R. Br. Prodr. 580. 1810; F. M. Bail. Queensl. Fl. 3: 894. 1900; Krause, Pflanzenr. 54(IV.277): 29. 1912.

BRITISH NEW GUINEA: Western Division, Oriomo River, Dagwa,

Brass 5931, February-March 1934, alt. 40 m., common on damp slopes of open ridges (ascending panicles of pale yellow flowers); Wassi Kussa River, Tarara, *Brass* 8385, December 1936, savannah forest, common in poorly drained gray soils (flowers yellow).

Apparently these are the first collections of this genus outside of Australia. The first collection cited was identified by Mr. C. T. White with the comment that it was a good match for the Australian plant.

Calogyne R. Brown

Calogyne pilosa R. Br. Prodr. 579. 1810; F. M. Bail. Queensl. Fl. 3: 905. 1900; Merr. Govt. Lab. Publ. 35: 68. 1905, Enum. Philip. Fl. Pl. 3: 589. 1923; Krause, Pflanzenr. 54(IV.277): 95. 1912.

BRITISH NEW GUINEA: Western Division, Oriomo River, Dagwa, *Brass* 5995, February-March 1934, alt. 40 m., common amongst grass on a savannah forest ridge (flowers brownish purple).

The species has been found previously in China, the Philippines, and Australia.

ARNOLD ARBORETUM,
HARVARD UNIVERSITY.

BRASSIANTHA, A NEW GENUS OF HIPPOCRATEACEAE FROM NEW GUINEA*

A. C. SMITH AND I. W. BAILEY

With one plate

A SPECIES occurring in the New Guinea collections of both Brass and Clemens was first called to the attention of the authors by Drs. E. D. Merrill and L. M. Perry, who, in their studies of the Celastraceae of these collections, came to the conclusion that the plant more probably belonged in the Hippocrateaceae than in the Celastraceae. Further study verified the conclusion that the species is a member of the Hippocrateaceae, although in many respects it is unique and far from typical of the family as previously understood. We propose to designate this plant as the type-species of a new genus, *Brassiantha*, so named in honor of Mr. L. J. Brass, whose extensive collections in New Guinea as a member of the Richard Archbold Expeditions have greatly enriched our botanical knowledge of the region. All material cited in this paper is deposited in the herbarium of the Arnold Arboretum. The first author has drawn up the formal description and has compared the plant with other genera of the Hippocrateaceae, while the second author has contributed the comments on the anatomical relationships of the new genus.

BRASSIANTHA A. C. SMITH, GEN. NOV.

Arbores parvae, ramis ramulisque gracilibus alternatis, foliis alternatis petiolatis, laminis chartaceis vel papyraceis; inflorescentiis ex axillis foliorum interdum delapsorum orientibus paniculatis vel pseudocymosis, ramulis paucis alternatis vel suboppositis bracteis parvis subtentis; floribus parvis in cymulas aggregatis vel apicem inflorescentiarum versus solitariis bracteolis inconspicuis pluribus suffultis; pedicellis gracilibus basim versus inconspicue articulatis; calyce cupuliformi, sepalis 5 anguste imbricatis; petalis 5 sub anthesi erecto-patentibus; disco carnosio annulari-pulvinato discontinuo (segmentis 5 oblongis distinctis sed contiguis composito); staminibus 5 erectis intra discum dispositis et segmentis disci alternatis, filamentis obscure ligulatis apice antheris

*Botanical Results of the Richard Archbold Expeditions.

articulatis, antheris extrorsis, connectivo conspicuo glanduloso, loculis 2 obliquis subapicalibus rimis distinctis (saepe contiguis vel subconfluentibus) dehiscentibus; ovario truncato-conico apice leviter depresso et stigmatibus inconspicuis radiatim signato, stylo nullo, loculis 5 staminibus alternatis, ovulis in quoque loculo 2-5 superpositis vel biseriatis (superioribus interdum singulis); inflorescentiis fructiferis valde incrassatis, fructibus paucis capsularibus subglobosis suturis loculicide dehiscentibus, pericarpio coriaceo, dissepimentis subcoriaceis; seminibus 2-4(-5) (raro abortu 1) ellipsoideo-oblongis suberectis superpositis vel irregulariter imbricatis in pulpo sparso ut videtur nidulantibus, testa membranacea, cotyledonibus crassis ut videtur confluentibus.

***Brassiantha pentamera* A. C. Smith, sp. nov.**

Arbor gracilis ad 10 m. alta ubique praeter flores interdum minutissime puberulos glabra, ramulis subteretibus fusco-cinereis; petiolis gracilibus leviter canaliculatis 3-10 mm. longis basi saepe paullo incrassatis; laminis siccitate fuscis vel olivaceis oblongo-ellipticis, (4-)5-12 cm. longis, (1.3-)2-4(-5) cm. latis, basi acutis et in petiolum decurrentibus, apice obtuse cuspidatis vel breviter acuminatis (acumine ad 6 mm. longo), margine integris, subtus saepe pallidioribus, costa supra leviter elevata subtus subprominente, nervis secundariis utrinsecus 5-9 brevibus patentibus marginem versus arcuatis et inconspicue anastomosantibus supra subplanis vel minute prominulis subtus manifeste prominulis, rete venularum immerso vel subtus leviter prominulo; inflorescentiis 5-18 mm. longis 4-15-floris, pedunculo gracili ad 8 mm. longo vel nullo (ramulis in axillis foliorum paucis), ramulis brevibus, bracteis connatis vel singulis papyraceis oblongo-deltoides 0.8-1.4 mm. longis acutis margine integris vel undulatis; bracteolis basi pedicellorum plerumque 4-6 inconspicuis laxè imbricatis ut bracteis similibus sed 0.4-1 mm. longis; pedicellis sub anthesi 2.5-11 mm. longis apicem versus inconspicue incrassatis; floribus sub anthesi 2.5-3.5 mm. diametro; calyce obscure et parce albo-peltato-squamuloso, sepalis tenuiter carnosus late deltoideo-ovatis, circiter 0.7 mm. longis, 0.8-1.3 mm. latis, obtusis, margine subintegris et obscure scariosis; petalis submembranaceis oblongis, 1.7-2.5 mm. longis, 1-1.3 mm. latis, subacutis integris glabris vel utrinque obscure puberulis; disco sub anthesi circiter 1.5 mm. diametro et 0.4 mm. alto basim versus tenuiore; filamentis circiter 0.5 mm. longis, connectivo transverse ellipsoideo circiter 0.3 mm. longo et 0.6 mm. lato, loculis 0.4-0.5 mm. longis; ovario carnoso sub anthesi 0.5-0.9 mm. longo et lato; fructus pedicellis ad 12 mm. longis et apicem versus 3-4 mm. diametro; fructibus ad 3 cm. diametro leviter 5-sulcatis,

pericarpio 2-4 mm. crasso utrinque levi, seminibus leviter falcatis circiter 12 mm. longis, 7 mm. latis, et 5 mm. crassis, uno latere rapha suberosa inconspicua carinatis.

NETHERLANDS NEW GUINEA: Hollandia and vicinity, alt. 20-50 m., *Brass* 8889 (tree 2 m. high, in rain-forest undergrowth; flowers red), *Brass* 8954, 8956 (TYPE), July 7, 1938 (bushy trees to 10 m. high, plentiful in secondary rain-forest on steep slopes; flowers red; fruits and seeds red). NORTHEASTERN NEW GUINEA: Morobe District, Ogeramang, alt. about 1800 m., *Clemens* 5082 (small tree, on forested hill above water-supply, the trunk about 7 cm. diam.; buds green, the flowers purplish red), *Clemens* 5413.

Of the cited material, the *Brass* specimens bear excellent flowers, 8954 and 8956 being accompanied by abundant mature fruits; both *Clemens* specimens have buds or very young opened flowers, 5413 having also a few fruits. In all respects the five specimens appear essentially identical. The fact that the plant is found near sea-level and again at 1800 meters may indicate that it is actually not uncommon; it seems likely that other collectors have obtained it, and one may expect to find additional specimens among those not yet referred to families.

Although *Brassiantha pentamera* bears little superficial resemblance to the members of the Hippocrateaceae, one observes, upon analysis of each character, that there is no reason to exclude it. Following is a discussion of these characters and remarks on the relationship of the new genus.

Transverse sections of the branchlets of *Brassiantha* are characterized by having zones or bands of septate fibers in the secondary xylem. Such a tendency for the replacement of banded apotracheal parenchyma by banded septate fibers occurs in *Maytenus* of the Celastraceae and in *Salacia* (and other related genera having drupaceous fruits) in the Hippocrateaceae. That *Brassiantha* belongs in one of these families is indicated by its unilacunar nodes and by an abundance of elastic material, viz. caoutchouc, in the leaves. Furthermore, the general histological and anatomical features of the pith, xylem, cortex, and leaf are indicative of such a relationship.

It should be emphasized in this connection, however, that there are conspicuous trends of structural specialization in the Hippocrateaceae which are closely correlated with transitional stages of the acquisition of a climbing habit of growth. Both the inner and the outer secondary xylem of non-scandent representatives of *Salacia* are of "normal" structure, whereas in subscandent or scandent species the first-formed

secondary xylem is of this type but the later-formed wood exhibits a more or less abrupt transition to a large-vesselled "anomalous" type of structure. Therefore, in studying the relationships of *Brassiantha* it is essential to focus one's attention upon comparisons with non-scandent species or with the more normal first-formed secondary xylem of scandent ones.

The wood of available species of *Salacia* differs from that of the celastraceous genus *Maytenus* in having narrower rays which frequently are dominantly uniseriate and with an evident tendency to form some paratracheal parenchyma. The xylem of the young stems of *Brassiantha* has high-celled mostly uniseriate rays and little or no paratracheal parenchyma. Thus, in this respect, the genus appears at first sight to be somewhat intermediate in structure between *Salacia* and the celastraceous genus. Unfortunately, there is no later-formed xylem available for determining whether multiseriate rays are formed during the later stages of the ontogeny of the stems. Such retardations in the formation of multiseriate rays occur not infrequently in the young stems of celastraceous genera. Furthermore, many additional species of *Salacia* and *Maytenus* must be studied in order to determine the range of structural variability within these genera. Therefore, it is not possible at present to refer *Brassiantha* to the Hippocrateaceae rather than to the Celastraceae solely upon the basis of diagnostic features of the secondary xylem.

Alternate leaves are unusual in the Hippocrateaceae, but they occur in several species of *Salacia*, *Tontelea*, *Peritassa*, and perhaps elsewhere; subopposite, rather than strictly opposite, leaves are common. The characters of *Brassiantha* pertaining to the inflorescence, bracts, bracteoles, pedicellary articulation, sepals, and petals are not unusual for the Hippocrateaceae.

The disk in the Hippocrateaceae is annular and continuous in all genera except *Cheiloclinium*, where it is disjunct into small pockets each subtending a stamen (see A. C. Smith, *Brittonia* 3: 525-550. fig. 12. 1940). In *Brassiantha* the disk is composed of five pulvinate glands which are contiguous at the ends to form a pseudocontinuous annular disk. Actually, this is not a continuous disk in the sense of other Hippocrateaceae, but it does not seem any more remarkable in its way than the disk of *Cheiloclinium*. As there is no doubt that the latter genus belongs in the family, one cannot exclude *Brassiantha* on the basis of its disk, which is, however, quite unique and certainly a character of generic value.

Throughout the Hippocrateaceae, stamens are three (sporadically two or four), except for two species of *Cheiloclinium* in which they are con-

sistently five. The presence of five stamens, therefore, cannot be used to exclude our plant. The stamens of *Brassiantha* are situated within the disk, which is normal for the family (but not for the Celastraceae), and they are opposite the breaks in the disk. This is quite the reverse of their position in *Cheiloclinium*, where they are opposite the centers of the portions of disjunct disk. The presence of swollen connectives has been occasionally noted in *Cheiloclinium* and *Peritassa*, but *Brassiantha* has them much more conspicuous; this, however, is hardly an excluding character. The locules and their dehiscence are normal for the family. The pollen of *Brassiantha* clearly falls within the range of structural variability of the Hippocrateaceae. In this connection, however, it is of interest to note that the pollen of the Celastraceae exhibits a similar range of variability in size, form, and structure as that of the Hippocrateaceae.

As to the ovary, the lack of a style is remarkable, occurring elsewhere in the Hippocrateaceae only in *Cheiloclinium*. In the latter genus the stigmas are sessile and radiating on the summit of the ovary but always obvious; in *Brassiantha* the stigmas are obscure, apparently reduced to minute radiating lines in the hollow of the ovary-summit. This apical hollow is not elsewhere found in the family. The arrangement of septae opposite the stamens is normal (in the species of *Cheiloclinium* with five stamens there are also five locules). Superposed ovules are common in the family, and their inner basal position is characteristic.

The fruit of *Brassiantha* is unique for the Hippocrateaceae. In other genera the fruit is either capsular and extended into three large wings or indehiscent and drupaceous. In *Brassiantha*, the fruit is capsular and dehiscent but not developed into wings, i.e. the vertical axis is not atrophied as it is in *Hippocratea* and allied genera. The loculicidal dehiscence of the fruit of *Brassiantha* is paralleled in the other dehiscent-fruited genera, in which each capsule dehisces down the middle. In a family with such great variation in its fruits, there is nothing fundamental about the fruit of *Brassiantha* which will serve to exclude the genus. The seed appears essentially similar to that of the drupaceous-fruited genera, with large cotyledons; in this case the cotyledons seem to be fused.

To summarize, the genus *Brassiantha* appears to have no characters which can be used to exclude it from the Hippocrateaceae. On the other hand, it is so distinct from known genera, in the characters of its disk, stamens, ovary, and fruit, as to make comparison superfluous. It appears to be rigidly excluded from the Celastraceae, as that family is at present constituted, by the position of the stamens within the disk.

This, indeed, may be the only fixed character by which the families Hippocrateaceae and Celastraceae may be separated. If so, one must consider the families quite artificial, especially since they exhibit parallel series of variations in characters pertaining to wood-anatomy and pollen-structure.

EXPLANATION OF PLATE

FIG. *a*. Flowering branchlet, $\times \frac{1}{2}$; *b*. Inflorescence, $\times 2$; *c*. Flower, $\times 5$; *d*. Sepal, $\times 10$; *e*. Petal, $\times 10$; *f*. Flower with sepals and three petals removed, $\times 15$; *g*. Stamen, exterior view, $\times 30$; *h*. Stamen, lateral view, $\times 30$; *i*. Longitudinal section through flower, $\times 15$; *j*. Fruit, $\times 1$; *k*. Fruit with two carpels removed, $\times 1$.

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BRASSIANTHA PENTAMERA A. C. SMITH

STUDIES IN THE THEACEAE, VII THE AMERICAN SPECIES OF THE GENUS CLEYERA

CLARENCE E. KOBUSKI

THE genus *Cleyera*, well known and generally accepted as a distinct genus of the Theaceae by students of the Asiatic flora, has been included under the genus *Eurya* by workers on the flora of tropical America. This is probably due to the fact that Szyszyłowicz, in the first edition of Engler and Prantl's *Natürliche Pflanzenfamilien*, treated *Cleyera* as a section of *Eurya*. Included here also as a section was the American genus, *Freziera*. Urban in 1896 protested vigorously at this treatment (and rightly so), feeling that all three should be retained as distinct genera. However, Melchior, in the second edition of Engler and Prantl's work, followed the lead of Szyszyłowicz, if perhaps a little less strongly, and raised the questionable sections of Szyszyłowicz to subgenera.

The genus *Eurya* is confined to the eastern hemisphere and is characterized by dioecious flowers and by having the stamens uniseriate in multiples of five, with glabrous anthers. The pedicels are quite short (usually less than 5 mm.) and decidedly curved. The petals are joined for approximately one-third of their entire length.

Cleyera ranges through the tropics and subtropics of both hemispheres and can be distinguished from the genus *Eurya* by the hermaphroditic flowers and the uniseriate stamens, usually in multiples of five, often in odd numbers, with distinctly setose anthers. The pedicels are seldom less than 10 mm. long (often up to 20–25 mm.), sturdy and conspicuous. The petals are joined only lightly at the base.

Cleyera was first described by Thunberg in his *Nov. Gen.* 3: 69. 1783 and was named in honor of the physician and botanist Andrew Cleyer, Dutch Director of Commerce during the years 1683–1688. Thunberg described a single species, *Cleyera japonica*, and based his description on plants growing near Nagasaki, Japan.

Unfortunately, this description was based upon two shrubs, as an examination of the type indicates. Nearly filling the sheet is an ample specimen of *Cleyera japonica*, while in the upper right corner is a fragment or near fragment of *Ternstroemia gymnanthera* (W. & A.) Sprague. Later, realizing the discrepancy mentioned above, Thunberg

came to the conclusion that *Cleyera* was congeneric with *Ternstroemia* and transferred his *Cleyera japonica* to *Ternstroemia* under the name *T. japonica*.

In 1841, Siebold & Zuccarini took up the original name *Cleyera*. They drew attention to the fact that Thunberg undoubtedly did have the two distinct elements at hand when he first described *Cleyera*. At the same time, however, they emended his description and pointed out that careful study showed that, regardless of what material Thunberg had, his actual generic description was based on the specimen of *Cleyera* and could refer only to *Cleyera*. True enough, in the specific description, the leaf arrangement refers to *T. japonica* (*T. gymnanthera* Sprague). However, this does not affect the status of the genus. They cleared up the whole matter and treated in detail both original elements under their respective genera and gave the specific epithet "*japonica*" to both. Recently Sprague, realizing that *T. japonica* could not be retained, made the combination *T. gymnanthera* (W. & A.) Sprague.

With Siebold and Zuccarini's work, confusion should have ended, because their treatment of the whole subject seems very clear and quite final. Sprague's treatment of the generic status of *Cleyera* in Jour. Bot. 61: 17. 1923 did much to clear up the whole situation and probably directly or indirectly caused the name *Cleyera* to be placed on the list of "nomina conservanda" by the International Congress of 1935.

The generic name *Sakakia* is clearly a true synonym of *Cleyera*. This name was proposed by Nakai, who hoped to clear up the involved synonymy. Evidently unaware of or ignoring the action taken by the International Congress in the case of *Cleyera*, the Japanese botanists have all rallied to Nakai and wholeheartedly accepted the name *Sakakia*. Incidentally, this name would have been most fitting since *Cleyera japonica*, the type of the genus, is generally known throughout the Japanese Empire as "Sakaki." From ancient times the species has been known and revered. It grows wild in the mountainous districts and can be found planted around the homes and about Shinto shrines. It is sometimes called "Mijam Sakaki" meaning "God-of-the-high-mountains." "Tamakushige" a kind of wand, dedicated to the gods, has been made from this plant, explaining the name "Tree-of-God." According to Siebold and Zuccarini, the Buddhists revere the tree because their priests maintain it is a species close to the "Sara tree" under which the founder of their cult died.

Besides the type species itself, there are several varieties growing throughout Formosa, China, Tibet and India. Some of these have been

given specific status at times but are usually considered varieties. The species itself and all its varieties, with the exception of *Cleyera japonica* var. *lipingensis* (Hand.-Mazz.) Kobuski are entire-leaved. In the western hemisphere, all species except *C. albo-punctata*, *C. Ekmani* and *C. integrifolia* have crenulate or serrulate leaves.

Treatment of the Asiatic species was made by the writer in Jour. Arnold Arb. 18: 118–129. 1937. The present paper is concerned only with the species of the western hemisphere. The specimens used in this study and cited in this current paper are from the herbaria of the Arnold Arboretum (AA); Gray Herbarium (G); Field Museum of Natural History (FM); Missouri Botanical Garden (MO); New York Botanical Garden (NY); and the United States National Museum (US).

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Tristylum Turczaninow in Bull. Soc. Nat. Moscou, 31, 1: 247. 1858.

Eurya § *Cleyera* Szyszylowicz in Engler & Prantl, Nat. Pflanzenfam. III, Abt. 6: 189. 1893.

Eurya subgen. *Cleyera* Melchior in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 21: 147. 1925.

Sakakia Nakai, Fl. Sylv. Kor. 17: 77, t. 19. 1928.

Trees or shrubs. Leaves evergreen or deciduous, entire or serrulate. Flowers hermaphroditic, solitary or in fascicles in the leaf-axils. Pedicels usually 1 cm. or more in length, thickened at the apex, bibracteolate, the bracteoles minute, subopposite or alternate near apex of pedicel. Sepals 5, imbricate, unequal, the outer sepals smaller, ciliate. Petals 5, imbricate, connate at the very base. Stamens about 25; anthers setose, biloculate with longitudinal openings. Ovary usually glabrous, 2–3-celled, with many ovules; style elongate, 3- or 4-fid at the apex. Fruit indehiscent, baccate, spherical or ovoid, many-seeded; seeds with thin endosperm and curved embryo.

TYPE SPECIES: *Cleyera japonica* Thunberg, emend. Siebold & Zuccarini.

KEY TO THE SPECIES

A. Leaves entire.

- B. Pedicels up to 25 mm. long with persistent bracteoles 4-5 mm. long; sepals up to 8-9 mm. wide; stamens with filaments 5-9 mm. long, the anthers 2.5 mm. long. (Cuba, Porto Rico).....1. *C. albo-punctata*.

- BB. Pedicels 10-14 mm. long (rarely up to 20 mm. long in *C. integrifolia*) with bracteoles, when present, not over 2 mm. long; sepals 4 mm. wide or less; stamens with filaments not over 3.8 mm. long, the anthers not over 1.2 mm. long.

- C. Flowers large; petals 7-9 mm. long, 6.0-6.5 mm. wide; sepals always glabrous; leaves rounded or emarginate at apex. (Cuba).2. *C. Ekmani*.

- CC. Flowers medium-sized; petals not over 5 mm. long; sepals usually pubescent, at least at first; leaves acuminate at apex. (Mexico).3. *C. integrifolia*.

AA. Leaves crenate or serrulate.

D. Leaves membranaceous.

- E. Leaves oblique, elliptic, rounded at base, the lateral veins numerous and evident on both surfaces. (Dominican Republic).4. *C. Bolleana*.

- EE. Leaves symmetrical, obovate, cuneate at base, the lateral veins 8-10, inconspicuous on both surfaces. (Chiapas, Mexico).5. *C. Matudai*.

DD. Leaves coriaceous.

- F. Leaves over 5 cm. long, obtuse or acuminate at apex.

- G. Leaves, branchlets, pedicels and calyx definitely pubescent.

- H. Inflorescence 9-10-flowered; calyx-lobes acute, connivent. (Mexico).6. *C. cernua*.

- HH. Inflorescence 1-2-flowered; calyx-lobes obtuse, not connivent.

- I. Leaves revolute, oblanceolate, 1.5-2.5 cm. wide, obtuse or rounded at apex; styles 3-4 parted. (Guatemala).7. *C. revoluta*.

- II. Leaves not revolute, obovate, 3-5 cm. wide, obtusely acuminate at apex; styles always 3-parted. (Guatemalan-Mexican border).8. *C. tacanensis*.

- GG. Young parts and branchlets glabrous or occasionally lightly pubescent, quickly glabrescent.

- J. Ovary hirsute near apex; style small, 1.25-1.50 mm. long; calyx and pedicel densely hirsute. (Mexico).9. *C. serrulata*.

- JJ. Ovary glabrous; styles ca. 3 mm. (2–3 mm. in *C. theaeoides*), calyx and pedicel glabrous or glabrescent.
- K. Pedicels short (5–7 mm. long); petals white. (Guatemala, Mexico).10. *C. Skutchii*.
- KK. Pedicels 10–14 mm. long; petals yellow, greenish yellow or greenish white.
- L. Leaves 3–5 cm. long, sharply serrate. (Costa Rica).11. *C. costaricensis*.
- LL. Leaves 4–8 cm. long, crenate or crenulate.
- M. Calyx pubescent; petals ca. 6 mm. long.
- N. Shrub; petiole 4–7 mm. long; lateral veins 7–10. (Cuba).12. *C. nimanimae*.
- NN. Tree; petioles 7–10 mm. long; lateral veins ca. 12. (Panama, Costa Rica). 13. *C. panamensis*.
- MM. Calyx glabrous; petals ca. 10 mm. long. (Jamaica). . .14. *C. theaeoides*.
- FF. Leaves less than 4 cm. long, rounded or emarginate at apex.
- O. Leaves less than 2 cm. long, less than 1 cm. wide, appressed pilose beneath, the petioles 1–2 mm. long; internodes 2–3 mm. long. (Haiti). . .15. *C. vaccinioides*.
- OO. Leaves 2.0–3.3 cm. long, 1.5–1.9(2.2) cm. wide, glabrous beneath, the petioles 3–5 mm. long; internodes 5–6 mm. long. (Haiti).16. *C. ternstroemioides*.

1. ***Cleyera albo-punctata*** (Grisebach) Krug & Urban in Bot. Jahrb. 21: 537. 1896.

Ternstroemia albo-punctata Grisebach, Cat. Pl. Cuba, 36. 1866.

Eurya albo-punctata (Grisebach) Melchior in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 21: 147. 1925.

Erotemum albo-punctatum (Grisebach) Britton in Britton & Wilson, Sci. Survey Porto Rico & Virgin Isl. 5: 582. 1924.

DISTRIBUTION: West Indies (Cuba and Porto Rico).

CUBA. Oriente: Sierra Nipe, near Woodfred, edge of pines, alt. ca. 550 m., *J. A. Shafer* 3050, 3455 (NY), 3148 (NY, G), Dec. 1909–Jan. 1910 (shrub or small tree 15–20 ft. with cream colored flowers). — Camp La Gloria, south of Sierra Moa, *J. A. Shafer* 8115, 8183, 8297 (NY), Dec. 1910–Jan. 1911 (shrub or tree 12–20 ft.; flowers pendent, creamy white; fruit long-pedicelled, red). — Loma del Gato and vicinity of Cobre range of the Sierra Maestra, alt. 850 m., *Fre. Leon, Clement & M. Roca* 10006 (NY), July 11–Aug. 14, 1921 (tree 10 m. or more tall; flowers yellow).

PORTO RICO. Humacao: Sierra de Naguabo, Monte el Duque, mountain forest, *J. A. Shafer* 2242 (NY), Mar. 8, 1914. — Same locality, Rio Prieto and adjacent hills, thickets at top of peak, alt. 1000 m., *J. A. Shafer* 3643 (FM, MO, NY), Aug. 1914 (scrubby tree, 10 ft. with white flowers). — Same locality, thickets at summit of El Duque, alt. 750–1080 m., *J. A. Shafer* 3659 (NY), Aug. 13, 1914 (straggling tree, 8 ft.). — Rio la Mina, Rio Piedras, *C. L. Horn* 49 (NY), April 1934 (tree 50 ft., short trunk with large, long, spreading branches; bark smooth brown; flowers greenish white). Mayaguez: in forest near Mariacao, *P. Sintenis* 193 (G, MO, NY) Dec. 10, 1884. Luquillo: Sierra de Luquillo, in sylvis montis Yunque, *Sintenis* 1362 (G), July 14, 1885.

This species is easily distinguished by its large flowers (an inch or more across), the petals of which are strikingly pubescent along the medial strip on the dorsal surface. Persistent, subopposite bracteoles, 4–5 mm. long and wide at the apex of the smooth but rugged pedicels are other characters of note. The species is glabrous except for the individual terminal buds.

The leaves are thick-coriaceous, obovate to obovate-elliptic, rotund or occasionally emarginate at the apex, 5–11 cm. long and 2.0–5.5 cm. wide with the midrib deeply impressed on the upper surface. The under surface is much lighter in shade, the margin revolute, entire or very slightly serrate.

The flowers are solitary or occasionally in two's in the axils; the pedicels are sturdy, 1.0–2.5 cm. long, thickening toward the calyx, up to 2.5 mm. diam. at the point of juncture. The persistent bracteoles are larger than the calyx-lobes of the majority of species in the genus, ca. 4–5 mm. long and 4 mm. broad, deltoid or subrotund, apiculate at the apex. The calyx is typical of the genus, 5–6 mm. long and up to 8 mm. wide, especially leathery, obtuse or subrotund at the apex, the margin scarious. The petals are larger than those of most species (up to 12 mm. long and 7–10 mm. wide) with a scarious margin up to 2.5 mm. wide; the dorsal surface has a strip of dense shining pubescence.

The stamens, about 35 in number, have long filaments (5–9 mm.) and short anthers (ca. 2.5 mm.) which vary in the amount of pubescence. The ovary is glabrous and the style is three-parted for only a short distance from the apex.

The Porto Rican material usually has shorter pedicels and generally smaller flowers than the Cuban specimens.

Here might possibly be cited *Fuertes* 1054 from Santo Domingo. The leaves are smaller, 2.5–5.0 cm. long, acute and mucronulate at the

apex. The flowers, as well, are smaller; the petals only sparingly pubescent. Also, *Fr. Leon 12246* from Cuba probably represents only a slight variation and should be cited here. The young branchlets and the under surface of the younger leaves are puberulent.

2. **Cleyera Ekmani** (O. C. Schmidt), comb. nov.

Eurya Ekmani O. C. Schmidt in Rep. Spec. Nov. 22: 97. 1925.

Freziera Ekmani (O. C. Schmidt) Kobuski in Ann. Missouri Bot. Gard. 25: 354. 1938.

DISTRIBUTION: West Indies (Cuba).

CUBA: Prov. Oriente, Sierra Maestra, Arroya Jiménez, alt. 600–900 m., *E. L. Ekman 14792* (paratype of *Eurya Ekmani*, NY), Aug. 9, 1922 (tree with white flowers).

Cleyera Ekmani is glabrous except for the leaf-buds and very young branchlets; shortly these both become glabrous. The leaves are glabrous, coriaceous, oblong-obovate or oblong-elliptic, 4–6 cm. long and 1.3–2.0 cm. wide, obtuse at the apex, cuneate at the base, entire or slightly denticulate at the apex, light green on the upper surface, brownish below (exsicc.). The petiole measures 3–4 mm. in length.

The flowers are found singly or in two in the axils, supported by glabrous pedicels 10–14 mm. long. The bracteoles (ca. 1 mm. long and broad) are suborbicular, ciliolate at the margin. The sepals are also suborbicular, unequal, \pm 4 mm. long and wide, and ciliolate at the margin. The petals (fide O. C. Schmidt) are 7–9 mm. long, 6.0–6.5 mm. wide, pubescent up the middle of the dorsal surface. The stamens (fide O. C. Schmidt) ca. 25, the filaments 3.8 mm. long, the anthers elliptic, \pm 1.2 mm. long, (pilose?). The ovary (fide Schmidt) subglobose, 3-celled, each cell containing approximately 25 ovules, with a style ca. 2.2 mm. long, three-parted.

Cleyera albo-punctata (Grisebach) Krug & Urban is the closest ally but can be easily separated by its much larger flowers (an inch or more across), the larger bracteoles (4–5 mm. long and wide), the sturdy pedicels (up to 2.5 cm. long), the larger calyx-lobes (5–6 mm. long and up to 8 mm. wide), the long filaments (up to 9 mm.), and the larger leaves (5–11 cm. \times 2.0–5.5 cm.).

3. **Cleyera integrifolia** (Bentham) Choisy in Mém. Soc. Phys. Hist. Genève 14: 110. 1855.—Hemsley, Biol. Centr.-Amer. 1: 93. 1879.—Urban in Bot. Jahrb. 21: 539. 1896.

Freziera integrifolia Bentham, Pl. Hartweg. 6. 1839.

Cleyera syphilitica Choisy in Mém. Soc. Phys. Hist. Genève 14: 110. 1855.—Urban in Bot. Jahrb. 21: 259. 1896.

Ternstroemia syphilitica Pavon ex Choisy, loc. cit. in synon.

Eurya integrifolia (Benth) Blume, Mus. Bot. Lugd.-Bat. 2: 105. 1856. — Szyszyłowicz in Engler & Prantl, Nat. Pflanzenfam. III. 6: 190. 1893. — Melchior, op. cit. ed. 2, 21: 147. 1925.

Tristylidium mexicanum Turczaninow in Bull. Soc. Nat. Moscou, 31, 1: 248. 1858.

Cleyera mexicana (Turcz.) Planchon ex Hemsley, Biol. Centr.-Amer. 1: 93. 1879.

Eurya syphilitica (Choisy) Szyszyłowicz in Engler & Prantl, Nat. Pflanzenfam. III. 6: 189. 1893. — Melchior, op. cit. ed. 2, 21: 147. 1925. — Bullock in Kew Bull. Misc. Inform. 1936: 391. 1936.

Eurya mexicana (Turcz.) Szyszyłowicz in Engler & Prantl, Nat. Pflanzenfam. III. 6: 190. 1893. — Standley in Contrib. U. S. Nat. Herb. 23, 3: 823. 1923. — Melchior in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 21: 147. 1925.

Eurya Benthiana Bullock in Kew Bull. Misc. Inform. 1936: 391. 1936.

Freziera mexicana (Turcz.) Kobuski in Ann. Missouri Bot. Gard. 25: 355. 1938.

DISTRIBUTION: Mexico (Jalisco, Michoacan, Mexico and Guerrero).

MEXICO. Jalisco: Bolaños, among pines, *T. Hartweg* 18 (isotype of *Freziera integrifolia*, FM, G, NY), 1837 (shrub 8–10 ft.). Guerrero: Petlacala, north of Mine Santa Elena, streamside, alt. 1880 m., *Y. Mexia* 9041 (NY), Dec. 27, 1937 (common tree 9 m. high with red fruit). — Same general locality, oak and pine forest, alt. 2750 m., *G. B. Hinton* 15402 (AA), Dec. 30, 1939 (tree 10 m. high with dull white flowers). Mexico: Temascaltepec, *G. B. Hinton* 319 (AA), 1099 (FM), 3835 (AA), 3886 (AA, FM), 7192 (AA), 7227 (AA, NY), 7704 (FM, NY), 7990 (AA, FM, US), 1932–1939. Michoacan: vicinity of Morelia, alt. 2100–2400 m., *Bro. G. Arsène* 5371, 5663, 8461, 8474 (US). — Mountains above Cuernavaca, *C. G. Pringle* 6957 (AA, FM, G, MO, NY, US), Aug. 9, 1898; Zitacuaro, deforested hillsides, rocky soil, alt. 2380 m., *G. B. Hinton* 11950 (AA), June 10, 1938 (tree 15 m., flowers yellow-white); Barroloso, oak forest, alt. 2300–2600 m., *G. B. Hinton* 15085 (G), 15098 (G), Aug. 9–10, 1939 (flowers wax white); Barroloso, alt. 2300 m. *G. B. Hinton* 15374 (G), Oct. 22, 1939 (tree 8 m.). Without locality,? *Sessé & Mocino* s. n. (type of *Freziera syphilitica* Choisy, Genève 23952; photo FM).

In the past, *Cleyera integrifolia* has been separated from *C. syphilitica* by its sericeous calyx, shorter pedicels and smaller leaves. Standley, in 1923, joined these two species under *Eurya mexicana*. Careful study of considerable material reveals that, although this species varies widely in all these characters, it cannot be separated clearly into two entities. The calyx, in the type, is glabrescent, generally appears pubescent to a more or less degree and is extremely sericeous. However, variation can

be found grading from nearly glabrous material (*Hinton* 3835, 7227, 7704) to the extreme pubescence in the type. In all cases, except *Hinton* 15085, the anthers possess a few hairs. Also the pedicels vary in length. *Hinton* 15374, from general appearances, should meet the requirements of *C. syphilitica* nicely. The calyx-lobes appear glabrous, except at the apex, and the peduncles are nearly 20 mm. long. However, the leaves measure only 8.0×3.7 cm. In the type of *C. syphilitica* the pedicels are ca. 20 mm. long and the leaves ca. 9.5 cm. long. These measurements were taken from a photograph. One can only assume that the calyx is glabrescent. *Hinton* 15098 has a pubescent calyx, leaves measuring 7×4 cm., but peduncles up to 17 mm. long. *Hinton* 7704 has a nearly glabrous calyx but the peduncles are only 5–9 mm. long and the leaves measure only ca. 8.0×2.5 cm. *Hinton* 15402 has a pubescent calyx, peduncles 5–10 mm. long but leaves measuring up to 11 cm. long, exceeding the type of *C. syphilitica* in the last character.

4. *Cleyera Bolleana* (O. C. Schmidt) comb. nov.

Eurya Bolleana O. C. Schmidt in Rep. Spec. Nov. 33: 177. 1933.

Freziera Bolleana (O. C. Schmidt) Kobuski in Ann. Missouri Bot. Gard. 25: 354. 1938.

DISTRIBUTION: West Indies (Santo Domingo).

The distinguishing characters of this species are the membranaceous, oblique, elliptic leaves, 5.0–8.5 cm. long and 2.4–3.5 cm. wide, rounded at the base, narrow and acute at the apex, the margin minutely serrate-crenate, the midrib impressed above, rather thick and prominent below, the lateral veins numerous and evident on both surfaces.

No material of this species has been available for study. However, the original description shows clearly that the species belongs to *Cleyera*.

The only specimen of *Cleyera* from Santo Domingo examined by me is *Fuertes* 1054 cited dubiously under *C. albo-punctata*. I tried to place this specimen with Schmidt's *C. Bolleana* but the leaves are so thick and coriaceous that they could never be confused with the "membranaceous" leaves of the present species.

5. *Cleyera Matudai*, sp. nov.

Planta lignosa, arbor videtur, ramulis teretibus brunnescentibus pubescentibus. Folia membranacea, primo pubescentia mox glabrescentia, obovata, 7–11 cm. longa et 2.5–3.7 cm. lata, apice basique attenuata margine crenata, costa supra complanata, venarum ca. 8–10 paribus undique inconspicuis, petiolo 3–4 mm. longo. Flores axillares 1- vel 2-fasciculati; pedicelli glabri, ca. 8–12 mm. longi, bracteolis 2,

suboppositis vel alternatis, cito caducis; sepala 5, imbricata, inaequalia, glabra, 2.5–3.0 mm. longa et ca. 2.0–2.5 mm. lata, apice obtusa apiculata margine ciliolata; petala 5, inaequalia, imbricata, ca. 6 mm. longa et 5–6 mm. lata, glabra, apice subrotundata vel emarginata; stamina 30, uniseriata, filamentis 3.5–4.0 mm. longis basi incrassatis et petalis adnatis apice sparse hirsutis; antheris obovatis parvis 0.50–0.75 mm. longis basi attenuatis, loculis inaequalibus apiculatis; ovarium subglobosum, glabrum, ca. 2 mm. longum, in stylum attenuatum triloculare, multi-ovulatum; stylus parvus, 1.5–2.0 mm. longus, glaber, ad medio tri-partitus. Fructus ignotus.

DISTRIBUTION: Mexico (Chiapas).

MEXICO. Chiapas: Mt. Ovando, alt. 1250–2370 m., *E. Matuda* 2560 (AA, TYPE; FM, NY), July 1938. — Finca Irlanda, *C. A. Purpus* 7433 (AA, FM, G, MO, NY, US), June 1914.

In general appearance this species exhibits no outstanding obvious characteristics to distinguish it from other species. However, the stamens, 30 in number, with the small obovate anthers (0.50–0.75 mm.) attenuated at the base, and the filaments sparsely hirsute just below the anthers are characters that easily separate the species from all others. Also the short style (1.5–2.0 mm.), free for nearly $\frac{1}{2}$ its length and the membranaceous leaves are other distinguishing features.

Unfortunately, in both collections cited above, just the barest field notes are available. One can only surmise that the species is a tree in habit.

6. *Cleyera cernua* (Tulasne), comb. nov. . .

Freziera cernua Tulasne in Ann. Sci. Nat. sér. 3, 8: 338. 1847.

Eurya cernua (Tulasne) Szyszylowicz in Engler & Prantl, Nat. Pflanzenfam. III, 6: 190. 1893.

DISTRIBUTION: Mexico (Oaxaca).

OAXACA: Canetze, alt. 900 m., *H. Galeotti* 1686 (TYPE of *Freziera cernua*, Genève; isotypes NY, US; photo and fragment, FM); La Lagune, *C. Liebmann* 337, in part (NY, US); 338 (FM, US), August 1842.

This species is characterized by the outstanding rufous, pilose buds, branchlets and undersurface of leaves (especially the midrib). On the older branchlets this pubescence appears black. Other notable characters are the many-flowered fascicles and the connivent, acute calyxlobes.

Tulasne, in his original description, refers to the inflorescence as 2–4-flowered. Unfortunately, *Galeotti* 1686, from which the descrip-

tion was drawn, proves to be a very poor specimen. A photograph of the type in Geneva shows only eight flowers on the whole specimen. On both *Liebmann* 337 and 338 single fascicles possess up to 9–10 flowers, more flowers than can be found on the entire type specimen. Tulasne records the leaf-measurements as 8–10 cm. long and 3.5–4.5 cm. wide. The more complete Liebmann numbers show leaves up to 15 cm. long and 5 cm. wide. According to Tulasne, the calyx-lobes should be 4–5 mm. long and the pedicels 1.0–1.5 cm. long. On the isotypes (NY, US) the calyx-lobes are seldom over 3 mm. long and the pedicels are always less than 1 cm. long. Although only a millimeter or so in variation in length of calyx-lobes, this variation proves interesting because the three-parted style protrudes beyond the calyx-lobes after the petals have fallen. The calyx-lobes are more acute in this species than those of most other species of the genus and the outer lobes are mucronulate as well as ciliolate. Instead of spreading, as is usually the case, the calyx-lobes are connivent, even after anthesis. In the type, the bracteoles are subopposite and close to the calyx. In the Liebmann specimens the bracteoles are usually 2–3 mm. apart. The pedicels are recurved as are those of most species.

The species is most closely related to *C. integrifolia* (Bentham) Choisy, from which it can be separated by the many-flowered fascicles, the usually shorter pedicels, the densely rufous-pilose young parts, the more acuminate leaves, pilose beneath, with a tendency towards serration, and the acute connivent calyx-lobes.

7. *Cleyera revoluta*, sp. nov.

Arbor parva, ca. 10 m. alta, ramis ramulisque teretibus pubescentibus brunnescentibus. Folia 5–9 cm. longa, et 1.5–2.5 cm. lata, revoluta, coriacea, oblanceolata, pubescentia, apice obtusa vel subrotundata, basi cuneata in petiolum 7–10 mm. longum attenuata, supra viridia, subtus argentea, margine crenata, nervis lateralibus 8–10 undique subobscuris. Flores non visi. Fructus immaturi in axillis solitarii, apice leviter pubescentes, pedicellis pubescentibus scabris 1.5–1.7 cm. longis, bracteolis 2 suboppositis cito caducis, sepalis 5 inaequalibus imbricatis pubescentibus 3.0–3.5 mm. longis et 3.5–4.0 mm. latis subrotundatis, stylis persistentibus glabris 3.5–4.0 mm. longis, 3–4-partitis medio liberis.

DISTRIBUTION: Central America (Guatemala).

GUATEMALA: Dept. San Marcos, between La Vega ridge along Rio Vega and northeast slope of Volcán Tacaná, to three miles from Guatemala-Mexico boundary, in vicinity of San Rafael, alt. 2500–3000 m.,

J. A. Steyermark 36208 (FM), February 20, 1940 (tree 35 ft. tall; leaves "involute", coriaceous, rich dark green above, silvery beneath).

Although the material from which this species is described lacks both flowers and mature fruit, the fact that it represents a distinctive new species is unquestionable. Distinguishing characters are the revolute oblanceolate leaves, pubescent in the mature state rather than glabrescent, and the sturdy pubescent pedicels and calyx. The sparsely pubescent immature fruit suggests a pubescent ovary. In this character it resembles the Asiatic *Eurya trichocarpa* Korthals which possesses a densely hirsute ovary that on maturing becomes quickly glabrescent belying the specific name.

Since only two fair-sized fruits are present, one with a 3-parted style and the second with a 4-parted style, it seems inadvisable to sacrifice either of them for sectioning. In both cases the style is free for nearly one-half its total length.

8. *Cleyera tacanensis*, sp. nov.

Arbor 9-metralis, ramulis brunneis hornotinis pilosis. Folia obovata, subcoriacea, pubescentia, 5–10 cm. longa et 3–5 cm. lata, apice obtusa vel abrupte acuminata, basi cuneata, supra opaca, pulchre viridia, subtus pallidiora, margine acute serrata, costa supra canaliculata, venis utrinsecus 9–10 supra impressis, subtus manifeste prominentibus, petiolo 2–4 mm. longo. Flores pauci in axillis solitarii; pedicelli scabri, pubescentes, (5–) 7–12 mm. longi, crassi, apice 2 mm. diam., bracteolis cito caducis; sepala 5, pubescentia, inaequalia, imbricata, obtusa, 2.5–3.0 mm. longa et 3–4 mm. lata, ciliolata; petala 5, alba, inaequalia, imbricata, obovata, apice retusa, glabra (medio dorso excepta), 6–8 mm. longa et 7 mm. lata; stamina ca. 25, filamentis inaequalibus 3–5 mm. longis, antheris ovatis glabris 1.25–1.50 mm. longis apiculatis (etiam bi-apiculatus); ovarium subglobosum, glabrum 3 mm. longum et latum, rubidum, tri-loculare, multo-ovulatum; stylus crassus, 3 mm. longus et 1 mm. diam., ad medium tri-partitus. Fructus ignotus.

DISTRIBUTION: Central America (Guatemala) and Mexico (Chiapas).

GUATEMALA: Dept. San Marcos, along Quebrada Canjulá, between Sibinal and Canjulá, Volcán Tacaná, lower slopes, alt. 2200–2500 m., *J. A. Steyermark 36052* (TYPE, FM), Feb. 18, 1940 (tree 30 feet with subcoriaceous leaves and white flowers). — Dept. San Marcos, Rio Vega, near San Rafael and Guatemala — Mexico boundary, Volcán Tacaná, alt. 2500–3000 m., *J. A. Steyermark 36280* (FM), Feb. 20, 1940 (tree 25 ft. tall with rigid coriaceous leaves). — Dept. San Marcos, along Quebrada, Canjulá, between Sibinal and Canjulá, Volcán Tacaná, alt.

2200–2500 m., *J. A. Steyermark 36026* (FM), Feb. 18, 1940 (leaves subcoriaceous, rich green above, paler beneath).

MEXICO. Chiapas: Chiquihuite, Volcán Tacaná, alt. 2800 m., *E. Matuda 2845* (AA, NY), Mar. 27, 1939. — Pasitar, *E. Matuda 394* (AA, MO, US), Dec. 1936.

This unusual species is characterized by large, obovate, sharply serrate leaves of a distinctive subcoriaceous texture. The pedicels are sturdy (2 mm. diam. below calyx), scabrous pubescent. The calyx-lobes are quite densely pubescent, wider than long. The petals are white, unequal, large, wider than long (6–8 mm. long and 7–9 mm. wide) with a dense pubescence, similar to that of the calyx, found along the medial strip of the dorsal surface. The stamens have rather long filaments (3–5 mm.). The anthers are glabrous (unique for the genus) and the projection in some instances appears forked. The style is sturdy, ca. 3 mm. long, three-parted for one-third its length with an obvious tendency toward further separation.

There is considerable variation found in the other specimens cited above. *Matuda 394* is placed here dubiously. The leaves are less sharply serrate, in most cases appearing subentire. The flowers are many—but unfortunately only in bud. Upon dissection, the anthers are sparsely hirsute whereas in the type the anthers are glabrous.

The species seems to be quite localized in the vicinity of Volcán Tacaná on the Chiapas-Guatemala border.

9. *Cleyera serrulata* Choisy in Mem. Soc. Phys. Hist. Nat. Genève 14, 1: 110. 1855.

Ternstroemia serrulata Herb. Pavon, ex Choisy l. c.

DISTRIBUTION: Mexico (Hidalgo).

MEXICO: Hidalgo, vicinity of Chiconquiaco, *G. Schiede 325* (MO).—exact locality unknown, “*Sessé, Mociño, Castillo & Maldonado 2331*” (FM, probable isotype).

Choisy (l. c.) in making the combination states: “5 *Cl. serrulata*. Nob. — *Ternstroemia serrulata*. Herb. Pavon! — Plante du Mexique également fort analogue au *Cl. integrifolia* et offrant, comme celle-ci, des sépales velus; elle en diffère principalement par ses feuilles dentées en scie dans la partie supérieure.” No actual type was cited—nothing but a reference to a specimen in Herb. Pavon. However, Pavon was not known to have collected in Central America or Mexico where most species of *Cleyera* abound. No species of *Cleyera* has been found in Peru where Pavon did most of his collecting.

Standley (Contrib. U. S. Nat. Herb. 23, 1: 17. 1920) remarked that probably many Sessé and Mociño specimens were distributed from the Madrid herbarium by Pavon and through some error, Pavon's name was affixed to the labels. In the herbarium of the Field Museum of Natural History is a specimen from the herbarium of the botanical garden of Madrid (Norti Botanici Matritensis) collected by "Sessé, Mociño, Castillo et Maldonado . . . (1787-1795-1804)." This specimen has two labels (1) *Ternstroemia serrulata* and (2) *Ternstroemia parviflora* N. Arbor 13 ped. Probably Choisy had a duplicate of this specimen before him and cited it as *T. serrulata* Herb. Pavon. As Choisy stated in his brief description, the pubescent calyx and serrulate leaves separate the species from *C. integrifolia*.

Here also might be cited *C. A. Purpus* 6177 (MO) collected between Misantla and Naolinco, Vera Cruz, Aug. 1912. The serration of the leaves of this specimen is more outstanding than that found on the two specimens cited above.

One may assume from the specimens cited that the range of this species lies in southeastern Mexico. Since no complete description of this species has ever been recorded, the following description has been drawn from the type:

Small tree about 4 m. tall with brown glabrescent branchlets. Leaves coriaceous, obovate, glabrescent, 5-8 cm. long, 2-3 cm. wide, obtusely acuminate at the apex, dark green above, paler beneath, cuneate at the base, the margin serrulate, the lateral veins (8-10 pairs) impressed on the upper surface, conspicuous below, the petiole 4-5 mm. long. Flowers few, solitary in the axils, the pedicel appressed pilose, ca. 1 cm. long, the bracteoles quickly caducous; sepals 5, unequal, imbricate, densely hirsute, 3.0-3.5 mm. long, 3-4 mm. wide, rounded at the apex, the outer sepals apiculate; petals 5, unequal, imbricate, obovate, glabrous or sparingly pubescent on medial portion of dorsal surface, ca. 6 mm. long, 4-5 mm. wide, rotundate or emarginate at apex; ovary globose, ca. 2.5 mm. long, hirsute at the apex with pubescence extending sparingly onto style; style short, 1.25-1.50 mm. long, 3-parted, free for one-third distance. Fruit unknown.

10. *Gleyera Skutchii*, sp. nov.

Arbor ad 20-metralis (fide collectoris), ramulis brunneis hornotinis ad apicem subadpresse pilosulis, mox glabrescentibus. Folia oblongo-elliptica vel obovata, coriacea, glabra juventate excepta, 3.5-8.0 cm. longa et 1.0-2.7 cm. lata, apice acuminata, basi cuneata in petiolum 3-4 mm. longum attenuata, margine serrata, nervis lateralibus 10-12

undique prominentibus. Flores in axillis solitarii; pedicelli glabri, recurvi 5–7 mm. longi, bracteolis 2 suboppositis ovatis \pm 1.5 mm. longis cito caducis; sepala 5, inaequalia, imbricata, concava, pergameneacea, rotundata, exteriora pubescentia, 2.5–3.0 mm. longa et ca. 2 mm. lata margine ciliolata; petala 5, alba, glabra, inaequalia, imbricata, emarginata, ca. 6.0–6.5 mm. longa et 5–6 mm. lata; stamina uniseriata, ca. 25, filamentis 3–4 mm. longis basi manifeste crassis et petalis adnatis, antheris sparse hirsutis vel subglabris oblongis \pm 1 mm. longis apiculatis (0.25–0.50 mm. longis); ovarium subglobosum in stylum attenuatum, glabrum, ca. 2 mm. longum, tri-loculare, multi-ovulatum; styli 3, ad medium vel plerumque ad basin liberi. Fructus ignotus.

DISTRIBUTION: Central America (Guatemala) and Mexico (Chiapas).

GUATEMALA. Dept. Chimaltenango: Chichavac, alt. 2400–2700 m., *A. F. Skutch 545* (TYPE AA; isotypes FM, NY, US), Aug. 18, 1933 (common tree, 60 ft. high with white flowers). — Chichavac, dry oak woods, alt. 2400–2700 m., *A. F. Skutch 271* (US), Feb. 21, 1933. — Chichavac Tecpan, *J. G. Salas 1395* (FM), Dec. 1929 (tree 6–8 m.). Dept. Chiquimula: upper slopes of Montaña Tajurán, in vicinity of El Barriol, alt. 1200–1700 m., *J. A. Steyermark 30814* (AA, FM), Oct. 28, 1939 (tree 50 ft. with leaves dark dull green above). Dept. Zacapa: forested slopes near summit of Sierra de las Minas, near Finca Alejandria, alt. 2000 m., *J. A. Steyermark 29805* (AA, FM), Oct. 12, 1939 (shrub with sweet-scented, white flowers, the stamens yellow, the style green; leaves slightly thick, dark green above, paler beneath). Dept. Jalapa: Cerro Alcoba, just east of Jalapa, oak woods near summit, alt. 1300–1700 m., *J. A. Steyermark 32559* (FM), Dec. 2, 1939 (tree 20 ft. with firm subcoriaceous leaves, dark green above, pale silvery gray beneath). — Between Miramundo and summit of Montaña Miramundo, between Jalapa and Mataquescuintla, six miles south of Miramundo, alt. 2000–2500 m., *J. A. Steyermark 32778* (FM, NY), Dec. 5, 1939 (tree 20 ft. with leaves dark green above, silvery beneath, "*barratillo*"). Dept. Guatemala: Volcán de Pacaya, above Las Calderas, in moist open forest, alt. 1800–2400 m., *P. C. Standley 58402* (FM), 58471 (AA, FM), Nov. 30, 1938 (large tree with greenish white flowers). Dept. Sacatepequez: Santiago, alt. 2000 m., *R. Gómez 790* (G, MO, NY, US). Dept. Sololá: Sololá, alt. 2250 m., *A. F. Skutch 1057* (AA) Aug. 27, 1934.

MEXICO: Chiapas, Mt. Pasitar, *E. Matuda S-211* (AA, MO, NY, US), Aug. 3, 1937.

This species is characterized by short pedicels (5–7 mm.), the white emarginate petals, the rather long filaments (3.5–4.0 mm.), swollen at the base, the anthers only slightly hirsute and distinctly apiculate (0.25–0.50 mm.) and the styles free to the base or nearly so. These characters serve to distinguish the species from *C. costaricensis*, its nearest relative.

The pedicels are unusually short for the genus. In the type, the bracteoles are situated at the apex of the pedicels, close to the calyxlobes, and are subopposite. In *Steyermark 29805* and *Standley 58471*, the bracteoles are alternate, with the lower bracteole situated nearly half-way down the pedicel. It is unusual to find white flowers in the genus; in most other species they are yellow, greenish yellow or even bronze.

Skutch 271, according to the collector, is a fruiting specimen of the type, or at least, of the same species. The leaves are much larger, up to 12 cm. long and 5 cm. wide and a mature fruit (crushed in pressing) measures about 1 cm. across.

Also dubiously cited here might be *E. A. Goldman 961* (US) from Teopisca, Chiapas. On this specimen the lateral veins number as many as fifteen pairs and in most cases appear nearly at right angles to the midrib, although in some leaves the lateral veins are at nearly forty-five degree angles.

11. *Cleyera costaricensis*, sp. nov.

Frutex 2–5 m. altus, ramulis griseis hornotinis ad apicem breviter et subadpresse pilosulis, mox glabrescentibus. Folia oblongo-elliptica, coriacea, glabra juventate excepta, 3–5 cm. longa et 1–2 cm. lata (etiam pauca 6–8 cm. longa et \pm 3 cm. lata), apice obtusa vel abrupte acuminata, basi in petiolum 2–3 mm. longum attenuata, margine serrata, nervis utrinsecus 10–11 subtus manifeste prominentibus. Flores in axillis solitarii vel plures; pedicelli glabri, recurvi, 10–14 mm. longi (*Stork 2592* ad 20 mm.), bracteolis 2 suboppositis vel ad 4 mm. distantibus linearibus 2–3 mm. longis cito caducis; sepala 5, glabra, concava, pergamenacea, acuta \pm 3 mm. longa et 2.0–2.5 mm. lata; petala 5, inaequalia, imbricata, cuneiformia, 6–7 mm. longa et 6–8 mm. lata, apice truncata vel retusa; stamina uniseriata, ca. 25, filamentis 2.0–2.5 mm. longis glabris basi manifeste crassis et petalis adnatis, antheris hirsutis obovatis \pm 1 mm. longis breviter apiculatis; ovarium subglobosum in stylum attenuatum, glabrum, ca. 2 mm. longum, triloculare, multi-ovulatum; stylus ca. 2 mm. longus, ad medium tripartitus. Fructus ignotus.

DISTRIBUTION: Central America (Costa Rica).

COSTA RICA: Forêts du Copey, alt. 1800 m., *A. Tonduz 11716* (TYPE, US), February 1898 (flowers green-white).—Cerro de las Vueltas, wet forest, alt. 3000 m., *P. C. Standley 43588* (US, FM), Jan. 1, 1926 (shrub 10–15 ft. with dark green leaves and bronze-green flowers).—Santa Clara hills, in old cut-over land, alt. 1800 m., *H. E. Stork 2592* (FM), June 6, 1928 (shrub 6 ft. with waxy yellow flowers).

This species is characterized by very small leaves (3–5 cm. long) especially on the flowering branches. Occasionally, larger leaves are present. In the type, two sheets of which were examined, only two leaves measured above 5 cm. The apex is acute and the base tapers into a short petiole. Except for the very young parts, the species is strictly glabrous. The pedicels are semi-recurved.

In *C. panamensis*, although originally described as small-leaved (specimens since collected prove the type exceptional) the leaves are obtuse or rounded at the apex, the margin is crenulate and the calyxlobes are covered with a short appressed pubescence.

12. *Cleyera nimanimae* (Tulasne) Krug & Urban in Bot. Jahrb. 21: 540. 1896.

Freziera nimanimae Tulasne in Ann. Sci. Nat. sér. 3, 8: 338. 1847.—Walpers, Ann. Sci. Nat. 1: 120. 1848.

?*Freziera ilicioides* Tulasne in Ann. Sci. Nat. sér. 3, 8: 337, 1847.—Walpers, Ann. Sci. Nat. 1: 120. 1848.

Cleyera nimanimae (Tulasne) Krug & Urban var. *β viridula* Krug & Urban in Bot. Jahrb. 21: 540. 1896.

Eurya nimanimae (Tulasne) Melchior in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 21: 147. 1925.

DISTRIBUTION: West Indies (Cuba).

CUBA: S. Yago, Pinol de Nimanima, *J. Linden 2128* (ISOTYPE of *Freziera nimanimae*, FM).—Southern Baracoa region, crest of Punta del Mata, alt. 1230 m., *Fr. Leon 12159* (NY), July–August 1924 (small tree, 5–6 m.).—Near Monte Verde, in dense woods, *C. Wright 1126* (ISOTYPE of *C. nimanimae* var. *viridula*, AA, G, FM, MO), Aug. 2, 1859 (tree 50 ft. with yellowish green flowers).

To my mind this is a rather dubious species. The type itself is distinguished from the other material at hand by the narrow oblong-elliptic leaves. It is closely allied to *C. theaeoides*, the Jamaican species, but can be separated by the leaf shape, smaller floral parts and the pubescent calyx.

The three specimens cited above conform quite well to the description

of the species. However, *Wright 1126* presents an interesting problem. There are available for my study five specimens of this number. Were it not for the specimen from the Field Museum, I could only conclude that two distinct species or forms had been included in the collection. However, this specimen has both the narrow elliptic leaves of *C. nimanimae* and the broader obovate leaves of *C. theaeoides* on a single branchlet.

Other specimens dubiously placed here are *Fr. Leon et al. 10610, 10172, 10979*, and *E. L. Ekman 14701*. These collections have broader leaves, similar in shape to *C. theaeoides*, still they possess the smaller flowers and pubescent calyx of *C. nimanimae*.

Urban, in a key to the West Indian species of *Cleyera*, separated these two species by the absence or presence of buds at the base of the pedicel, besides leaf-shape and size. In the type of *C. nimanimae*, *Linden 2128*, this character (absence of buds) does hold, but in *Fr. Leon 12159* (representing *C. nimanimae*) and the material examined of *C. theaeoides* both the presence and the absence of buds can be noted.

Dubiously cited under this species as a synonym is *Freziera ilicioides* Tulasne. Urban cited *F. ilicioides* under *Cleyera theaeoides*. Unfortunately, I have not been able to examine the type material but from the extensive description I feel that it is more closely associated with the present species.

13. *Cleyera panamensis* (Standley), comb. nov.

Eurya panamensis Standley in Woodson & Seibert in Ann. Missouri Bot. Gard. 25: 829. 1938; in Field Mus. Nat. Hist. Publ. Bot. Ser. 22: 169. 1940.

DISTRIBUTION: Central America (Panama and Costa Rica).

PANAMA. Prov. de Chiriquí: valley of upper Rio Chiriquí Viejo, alt. 1300–1900 m., *Gene & Peggy White 16* (TYPE of *Eurya panamensis*, FM; isotype, AA), July 16, 1937 (tree 10–12 m. high with white, very fragrant flowers).—Vicinity of Casita Alta, Volcán de Chiriquí, alt. 1500–2000 m., *Woodson, Allen & Seibert 791* (AA, FM, MO), June 28–July 2, 1938 (tree 6 m. high with yellow flowers).—Vicinity of Finca Lérída, Volcán de Chiriquí, alt. 1750 m., *Woodson & Schery 232* (AA, MO), July 7–11, 1940 (tree 10 m. high with yellow-cream flowers).—Vicinity of Callejón Seco, Volcán de Chiriquí, alt. 1700 m., *Woodson & Schery 499* (AA, MO), July 17, 1940 (tree 6 m. with pale yellow flowers).—Volcán de Chiriquí, Boquete Distr., open hillsides, alt. 1500–2700 m., *M. E. Terry 771* (AA, FM, MO), 785 (FM), 880 (AA, FM, MO), 922 (FM), 1350 (FM), June 26, 1935–

Feb. 13, 1940 (tree 5–9 m. with pale yellow, greenish yellow or greenish white flowers).

COSTA RICA: hills above Zarcero, in woodland, alt. 1800 m., *Austin Smith* A127 (AA, FM, MO), Aug. 14, 1935 (tree 6 m. with campanulate flowers [15 mm. across], pale citron yellow; bark dark gray, thick, granularly roughened, the wood white). — Alajuela, Palmira, alt. 2100 m., *Austin Smith* 4166 (FM), Apr. 30, 1937 (tree 50 ft.; 2 ft. diam. at base, bark grayish, corrugated; flowers semi-campanulate, yellow to mustard yellow, 15 mm. across). — Paso Ancho, alt. 1675 m., *C. H. Lankester* 287 (FM), June 1919.

Standley distinguishes this species by the small obovate leaves (2.5–5.5 cm. long, 1.0–2.5 cm. wide), very obtuse or rounded at the apex. On the type in the Field Museum, this character holds true. However, on the isotype in the herbarium of the Arnold Arboretum, leaves are found measuring up to 8 cm. \times 3 cm. Most of the specimens cited above have larger leaves, with the smaller leaves the exception. The apex of the leaves may be very obtuse or rounded or, as found on later specimens, obtuse but bluntly acuminate. Very characteristic are the densely hirsute, white or greenish white terminal buds. In a group of plants where characters are most variable, this character is consistent. The pubescence carries through on the very young branchlets and younger leaves, especially on the petiole and undersurface. The older leaves appear glabrous or nearly so.

The calyx-lobes, under the hand-lens, may seem glabrous, but under the binocular, they usually appear covered with a dense appressed pubescence. This pubescence is usually found on the inner surface of the calyx-lobes as well.

The serration of the leaves varies somewhat from the distinct dentation as found in the type to the nearly entire margin found in *Terry* 771 and 922.

From *C. costaricensis* this species can be separated by the obtuse acuminate or rounded apex, the texture and veining. In *C. costaricensis* the leaves are in some instances even smaller than the type of this species, quite coriaceous, acute at the apex and less abruptly acuminate.

14. *Cleyera theaeoides* (Swartz) Choisy in Mém. Soc. Phys. Hist. Nat. Genève **14**, 1: 110. 1855 "thoeoides." — Grisebach, Fl. Brit. West Ind. Isl. 103. 1859. — Urban in Bot. Jahrb. **21**: 538. 1896.

Eroteum theacoides Swartz, Prodr. 85. 1788. — Fawcett & Rendle in Jour. Bot. **60**: 362. 1922; Fl. Jam. **5**: 185. 1926.

Freziera theoides Swartz, Fl. Ind. Occ. **2**: 972. 1800. — Willdenow, Sp. Pl. **2**, 2: 1179. 1800. — Smith in Rees, Cyclop. **15**: no. 1. 1810. — De

Candolle, Prodr. 1: 524. 1824. — Macfadyen, Fl. Jam. 1: 115. 1837. — Hooker in Bot. Mag. 76: t. 4546. 1850. — Paxton's Fl. Gard. 1: 189. 1851. — Seemann, Bot. Voy. Herald, 87. 1853. — Triana & Planchon in Ann. Sci. Nat. Bot. sér. 4, 18: 264. 1862.

Eurya theoides (Swartz) Blume, Mus. Bot. Lugd.-Bat. 2: 105. 1856. — Szyszyłowicz in Engler & Prantl, Nat. Pflanzenfam. III. 6: 189. 1893. — Standley in Contrib. U. S. Nat. Herb. 23, 3: 823. 1923. — Melchior in Engler & Prantl, Nat. Pflanzenfam. ed. 2, 21: 147. 1925.

DISTRIBUTION: West Indies (Jamaica).

JAMAICA: vicinity of Cinchona, *N. L. Britton 109* (NY), Sept. 2–10, 1906. — Vicinity of Newcastle, hillside, Silver Hill to Hardware Gap, *N. L. Britton 3447* (NY), Sept. 11, 1908 (tree 10 m.). — Road to John Crows Peak, alt. 1860 m., *W. Harris 6513* (NY, FM), Sept. 8, 1896 (tree 10 m.). — Cinchona, Sir John's Peak, alt. 1830 m., *W. Harris 9514* (NY), Sept. 27, 1906 (small tree 10–12 ft.). — Content Road, alt. 900 m., *W. Harris 6104* (AA, NY), Nov. 21, 1895 (small tree, 15 ft.). — Morce's Gap, *W. Purdie s.n.* (G), June 1843; *J. H. Perkins 1132* (AA, G), May 22, 1916; *F. Shreve s.n.* (NY), Jan. 1906. — Cinchona, leeward slopes of Blue Mts., *J. A. Harris & J. V. Lawrence C 15180A, C 15361, C 15374A*, Feb. & Mar. 1916. — Blue Mountain near Portland Gap, alt. 1700 m., *A. Rehder s.n.* (AA), Feb. 11, 1903 (tree 20 ft. high with rather smooth brown bark; fls. yellowish white). — on summit of Blue Mountain Peak, alt. 2225 m., *A. Rehder s.n.* (AA), Feb. 11, 1903 (shrub 10 ft.). — extreme summit of Blue Mountain Peak, alt. 2262 m., *W. R. Maxon 1405* (US), Apr. 1903 (shrub 8–12 ft.). — Blue Mountain Peak, open southeastern slope of East Peak, alt. 2200 m., *W. R. Maxon 9949* (US), July 1926 (shrub 2.5 m.). — Blue Mountain Peak, summit, alt. 2250 m., *G. E. Nichols 116* (FM, G, MO, NY, US), July 21, 1903. — Gordon Town (Cinchona plantation), *J. Hart 593, 654, 1051* (US).

Shrubs or small trees up to 20 ft. Branchlets and terminal buds appressed pilose becoming glabrous. Leaves obovate or oblong-obovate, chartaceous-coriaceous, glabrous, 4–8 cm. long and 2–4 cm. wide, bluntly acuminate (rarely attenuate) at the apex, sharply or broadly cuneate at the base, the lateral veins inconspicuous above, prominent below, anastomosing near the crenulate or crenate margin; petiole 3–7 mm. long.

Flowers solitary, rarely in two's in the axils; pedicels glabrous, 1–2 cm. long, the bracteoles 2, usually deciduous before anthesis, when present, linear, membranaceous up to 2 mm. long; sepals unequal, semi-orbicular, glabrous, outer sepals smaller, 2.0–3.5 mm. across, inner sepals 3.5–5.0 mm. wide, ciliolate; petals \pm 1 cm. long, obtuse, glabrous

on dorsal surface; stamens 25–30, the filaments 3–5 mm. long, adnate to the base of the corolla, the anthers oval-elliptic, \pm 1 mm. long, sparsely hirsute; ovary glabrous, globose, 3-locular, 14–18 ovules in each locule, the style 2–3 mm. long, 3-parted with a tendency to split simulating *Eurya*. Fruit globose, about 1 cm. diameter.

The crenulate leaf-margin is similar to that found in the Japanese species, *Eurya japonica*.

In his original description of this species under the genus *Eroteum* (1788), Swartz used the spelling "*Theaeoides*." In 1800, under the genus *Freziera*, Swartz changed this spelling to "*theoides*." Choisy (1855), in making the transfer to the genus *Cleyera* used "*thoeoides*." Since then, most authors have used "*theoides*," the later spelling employed by Swartz. However, Fawcett & Rendle, as well as Sprague, in discussions over the correct generic name, used the original "*theaeoides*." Personally, I feel the second name more euphonious and it is surely easier to record. Nevertheless, to my mind, the change to this name by Swartz was merely an oversight. *I do not believe it to be a correction*. Since the original spelling seems correct enough grammatically, it should be employed.

From the material examined, one is not impressed by the range of the species in Jamaica. All the material seems to have been collected in the southeastern portion of the island, on or close to Blue Mountain. This is due, perhaps, to the fact that most collectors worked from a base established at Kingston. However, were it collected elsewhere, surely it would be found in one of the various herbaria, whose material I have at my disposal.

15. *Cleyera vaccinioides* (O. C. Schmidt), comb. nov.

Eurya vaccinioides O. C. Schmidt in Rep. Spec. Nov. 22: 98. 1925.

Freziera vaccinioides (O. C. Schmidt) Kobuski in Ann. Missouri Bot. Gard. 25: 355. 1938.

DISTRIBUTION: West Indies (Haiti).

HAITI: Massif de la Selle, Pétionville, slope of M. Le Visite, on top of limestone ridge in exposed situation, alt. 2100 m., *E. L. Ekman H 1438* (ISOTYPE of *Eurya vaccinioides*, US). — Massif de la Hotte, pinelands, alt. 2300 m., *E. L. Ekman H 10628* (US), Sept. 13, 1928.

The most outstanding character of this species is found in the minute elliptic or obovate leaves, measuring 1.0–1.8 cm. long and usually less than 1 cm. wide with a petiole 1–2 mm. long. Also, the leaves are coriaceous, punctate on the upper surface, appressed strigose pubescent beneath, the veins obscure and the margin revolute with a few dentations at the very apex.

Unfortunately, as Schmidt intimated in his original diagnosis, the petals and the stamens can be found only in the unopened buds. However, Schmidt states that the petals were suborbicular and densely pilose up the center. The pedicels are only 0.5 mm. long.

Closely allied to *C. vaccinioides* is *C. ternstroemioides* which differs in its larger leaves (2.0–3.3 cm. long and 1.4–1.9[–2.2] cm. wide), glabrous on the under surface. In the latter species, the very young parts (branchlets and leaves) are appressed-pilose, later becoming glabrous. There are fewer leaves because of the longer internodes which are 5–6 mm. long as compared with the 2–3 mm. long internodes of *C. vaccinioides*.

16. ***Cleyera ternstroemioides*** (O. C. Schmidt), comb. nov.

Eurya ternstroemioides O. C. Schmidt in Rep. Spec. Nov. 24: 79. 1927.

Freziera ternstroemioides (O. C. Schmidt) Kobuski in Ann. Missouri Bot. Gard. 25: 355. 1938.

DISTRIBUTION: West Indies (Haiti).

HAITI: Massif de la Hotte, western group, Torbec, top of M. Formona, alt. 2225 m., *E. L. Ekman* H 7487 (ISOTYPE of *Eurya ternstroemioides*, US), January 1, 1927.

Cleyera ternstroemioides is characterized by glabrous, coriaceous elliptic to obovate leaves, 2.0–3.3 cm. long and 1.4–1.9(–2.2) cm. wide, rotund at both ends, with the margin slightly dentate at the apex, punctate on the upper surface, the midrib sulcate above, the veins obscure on both surfaces. The branchlets and leaves are appressed-pilose at first, later becoming glabrous. The pedicels are about 1 cm. long. The petals are obcordate-orbicular, 8.5–10 mm. long and 8–9 mm. wide, densely pilose on the medial portion of the dorsal surface, ciliolate along the margin. The anthers are sparsely hirsute.

Closely related is *C. vaccinioides* which can be separated by its even smaller flowers (one-half), the appressed-pilose undersurface of the leaves and branchlets, the short internodes (2–3 mm.) and pedicels (0.5 mm.).

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THE TRIBE PLUKENETIINAE OF THE EUPHORBIACEAE IN EASTERN TROPICAL ASIA

LEON CROIZAT

Two specimens of Euphorbiaceae were found in the collections made by C. W. Wang in Yunnan, during 1938, which have a gross morphology suggesting that of *Tragia* L. A dissection made of their flowers shows that: (1) the ♂ perianth has three broadly triangular lobes, alternating with as many large triangular stamens, with an apical dehiscence and very short appendages; (2) the stamens stand upon a short column, without a central pistillode, and are surrounded by a slightly upraised, eglandular annulus, suggesting a similar structure commonly found in certain Asclepiadaceae of the Tribe Stapelieae; (3) the ♀ flower bears a style much thickened at the apex, without expanded stigmas.

Characters of this kind belong to several genera in the vicinity of *Tragia*, for instance, *Cnesmone* Bl., *Sphaerostylis* Baill., *Megistostigma* Hook f., *Clavistylus* J. J. Sm., *Cenesmon* Gagnep., and *Tragiella* Pax & Hoffm. Before the Wang collections could be determined all these genera had to be studied in detail, which necessarily entailed a consideration of the Tribe PLUKENETIINAE and its nearest allies. The result of this investigation proved to be fruitful of taxonomic and nomenclatural changes which are the subject of the present contribution.

In their latest work on the Euphorbiaceae, Pax & Hoffmann (Nat. Pflanzenfam. 19[c]: 141–148. 1931) includes *Cenesmon* among the genera of the MERCURIALINAE. It is not apparent why they should do this, since they remark “Die Gattung zeigt Beziehung zu *Cnesmone*”, which is closely related to *Tragia*, the type-genus of the PLUKENETIINAE. *Tragia* alone numbers about 140 species, and the balance of the species of the tribe, about 40, are distributed by Pax & Hoffmann among not less than twenty genera, eleven of which are monotypic. Clearly, genera of this nature cannot be critically worked out unless by making reference to *Tragia*, of which they are bound to be comparatively minor segregates.

Tragia is a critical genus, which Pax & Hoffmann (Pflanzenr. 68[IV.147. IX–XI]: 32–101. 1919) divide into nine so-called sections. These nine sections very nearly fall into two natural groups. In one

group the ♂ perianth is 3-lobed and the lobes alternate with as many stamens; in the other group, the ♂ perianth is 5-lobed and the stamens tend to be numerous. The styler structure of the genus is variable throughout. Some species have evolute columns with divaricate stigmas (see, for instance, *T. Sellowiana* Muell. Arg. and *T. leucandra* Pax & Hoffm.). Others, on the contrary, have branches of the style that become divergent at the very top of the ovary (see, for instance, *T. geraniifolia* Baill. and *T. mitis* Hochst.). The stigmatic surfaces are more or less thickly and finely papillose. The stamens are more or less elongated, sometimes mixed with staminodes, but so far as I know the anthers bear no appendage arising from an extension of the connective between the cells, and the filaments are almost always delicate.

Like the majority of the genera of the Euphorbiaceae, *Tragia* is a natural group, covering species that are unlike in their morphology and, even more, in their tendencies. Such a group is essentially defined by negative characters and cannot be broken up at will into lesser units merely because some of its forms happen to have characters in their flowers that do not exactly fit the standard generic definition. *Tragia* is a phylogenetic node from which have radiated forms that ultimately have evolved along lines of their own. One of such lines, for instance, can readily be identified. It begins with the coarsely papillose and thick style of certain species of *Tragia*, and through *Cnesmone* it ends in *Plukenetia*, the styler structures becoming larger and more deeply and intimately connate as the evolutive trend unfolds itself.

The earliest segregate from *Tragia* recorded in the botany of tropical Asia is *Cnesmone*. In publishing it as *Cnesmosa* (Bijdr. 12: 630. 1825, corrected to *Cnesmone* in Blume & Fischer, Fl. Jav. 1: vi *in nota*. 1828¹), Blume laid stress upon the following: "Genus a *Tragia* diversum calice in femineis 3-sepalo, stigmatibus sessilibus carnis intus verrucosis ut etiam habitu". None of the characters emphasized by Blume can validly separate *Cnesmone* from *Tragia*. The *species lectotypica proposita* of *Tragia* is *T. volubilis* L., which has a 3-lobed ♂ calyx and a 6-lobed ♀ perianth, this type of flower being also characteristic of certain species of *Cnesmone*. As has been pointed out, "stigmatibus sessilibus carnis intus verrucosis" occur on *T. geraniifolia*. The habit,

¹This reference is usually cited, following Pax & Hoffmann, op. cit., 102, as "Fl. Jav. praef. VI. (1828)," which is misleading. The introduction to the Flora Javanica referred to as "praef." is an integral part of the first volume of this work, paged in Roman numerals. Many important corrections are effected by Blume in this introduction. *Cnesmosa* is a "clearly unintentional orthographic error" under Art. 70 of the Rules of Nomenclature, which Blume was justified in correcting. *Cnesmone* alludes to the urent hairs of the type-species, *C. javanica*, as pointed out by Pax & Hoffmann, op. cit., 102 *in nota*.

of course, is very much alike in the genera of the PLUKENETIINAE, and *Cnesmone* quite agrees with the gross morphology of *Tragia*.

The fundamental difference between *Cnesmone* and *Tragia* is that of the anthers, which bear a manifest connective between the cells in *Cnesmone* and are exappendiculate, on the contrary, in *Tragia*. This difference, overlooked by Blume, is emphasized by Pax & Hoffmann in their key to the genera of the PLUKENETIINAE, in which they (op. cit., 9) say of *Tragia*: "Stamina numerosa vel plura, saepius autem 3. Ovarium 3-loculare; styli superne liberi" and refer to *Cnesmone* as having: "Stamina normaliter 3 vel 2. Ovarium 3-loculare. Antherae appendiculatae. Styli superne liberi." Mueller Argoviensis, on his part (in DC. Prodr. 15[2]: 926. 1866), states that *Cnesmone* is "Planta fruticosa, scandens, habitu Tragiae, in Java et India orientali crescens, connectivi et stylorum indole insignita." This characterization of Blume's genus is correct, in the main. Unfortunately, it has often been read to mean that the thickened style of *Cnesmone* has generic importance. This is not necessarily true, because the stigma of *C. javanica* is essentially free, and as such is correctly illustrated by Pax & Hoffmann (op. cit., 103 fig. 23 E).

In his publication of *Cenesmon*, Gagnepain (in Bull. Soc. Bot. France 71: 865-866. 1924) notices that this genus differs from *Tragia* because it has appendaged anthers with spreading cells, coarse and conical papillae on the stigmas and no stylar column. He furthermore states that *Cenesmon* is unlike *Cnesmone* because it has stigmas that spread in anthesis, conical stigmatic papillae and no stylar column. It is to be feared that in emphasizing differences such as these, Gagnepain relies too much on characters of the flower that are unimportant in the Euphorbiaceae. Since in *Tragia* a stylar column may be present or absent, and the stigmas may be finely or coarsely papillate, no reliance can be put upon the nature of the stylar column and of the stigma to effect generic segregations in this group. Shorn of unessentials, Gagnepain's notes amount merely to this: *Cenesmon* is generically distinct from *Tragia* because it bears appendaged anthers, and it differs from *Cnesmone* in having stigmas that spread at the time of anthesis.

The fact that the stigmas tend to be inflexed rather than to expand has absolutely no systematic significance in the PLUKENETIINAE. In this tribe, the style varies a great deal in the different stages of its growth, which is proved by van Steenis' illustration of the style of *Clavistylus peltatus* J. J. Sm. The two states which van Steenis (in Bull. Jard. Bot. Buitenz. iii, 12: 201, fig. 10 d, e. 1932) shows are so different that taxonomists of the school of Gagnepain would hesitate in believing them to

be conspecific and perhaps even congeneric. At the very best, fully accepting the accuracy of Gagnepain's observations, *Cenesmon* could be maintained as a subsection of *Cnesmone* to include the species that have about reached a stage of evolution wherein their style *begins to look like* the style of certain species of *Tragia*. There can be no question of erecting two genera because the stigmas spread or fail to do so.

Cnesmone, as has been shown, differs from *Tragia* because it has appendaged anthers. Characteristically, *Cenesmon* is said by Gagnepain to differ from *Tragia* in the very same manner, that is to say, in carrying anthers that are appendaged. It is but a logical conclusion that *Cenesmon* is a synonym of *Cnesmone*, because none of the differences which are said to separate them has any value. It might be possible to treat *Cnesmone* as a subgenus of *Tragia*, denying generic validity to the presence or absence of the appendage in the anthers. Such a treatment, however, is neither necessary nor correct. *Cnesmone* is a good genus not because its anthers differ in some detail from those of *Tragia*. It is a good genus because it consists of species that are phylogenetically, phytogeographically and morphologically one unit, and form as such a natural group in the flora of eastern tropical Asia. It is conceivable that some of the species of *Cnesmone* may have anthers that are less manifestly appendaged than those of others, and that their position under *Cnesmone* may ultimately depend upon sums of intangibles rather than upon technicalities of floral morphology. Such technicalities have a very limited value in the Euphorbiaceae; were they stressed, every one of the fundamental genera of the family could be broken up into countless meaningless segregates.

I have not seen material of *Sphaerostylis Tulasneana* Baill. The classic illustrations of this species, prepared under the supervision of Baillon (Etud. Gén. Euphorb., *pl.* 21, *fig.* 19–21. 1858; in Grandidier, Hist. Madagascar 4[xxix]: *pl.* 196. 1890) are fortunately very clear. In view of what they show it is safe to conclude that *Tragiella* Pax & Hoffm. is merely a synonym of *Sphaerostylis*. The lobes of the ♀ calyx are manifestly pinnatifid in *Tragiella*, but they are at least toothed in *Sphaerostylis*. The peculiar coarctate ♂ perianth of the former is described by Pax & Hoffmann (op. cit., 104) as: "Calyx ♂ valvatis 3-partitus, parte inferiore campanulatus, ad faucem introrsum plicatus, lobi deinde patentes." The perianth of *Sphaerostylis* likewise is characterized by the two authors (op. cit., 106) as: "Calyx ♂ ultra medium valvatis partitus; lobi demum transversim introsum plicati, quasi discum simulantes." The lobes of the ♀ perianth are about 6 in both genera. The style of *Tragiella* is described as: "Styli in columnam infun-

dibuliformem, apice trilobam, vel in massam globosam connati," and that of *Sphaerostylis* as: "Styli in massam globosam, longitrorsum trisulcam, ovario multo majorem connati, summo apice brevissime liberi." The differences in the stamens of the two genera are just as trifling as are those in the styles. In *Tragiella* the stamens are described as: "Stamina 3-4, alternisepala; filamenta brevissima, basi incrassata et hic inter se connata; connectivum valde incrassatum; antherae introrsae, longitudinaliter dehiscentes; loculi paralleli. Ovarii rudimentum parvum evolutum, cum basi filamentorum connatum." In *Sphaerostylis* the stamens are said to be: "Stamina 3, alternisepala; filamenta fere nulla, in columnam connata; antherae in summa columna erectae, demum subreflexae, apiculatae; loculi introrsum contigui, paralleli, longitudinaliter dehiscentes. Ovarii rudimentum nullum." The presence of a pistillode, of course, is scarcely of significance in this tribe, because in the type-species of *Tragia* itself, *T. volubilis* L., the pistillode appears as: "Ovarii rudimentum nanum vel nullum" (see Pax & Hoffmann, op. cit., 48). In brief, since *Sphaerostylis* is based upon a plant from Madagascar, and the three species brought under *Tragiella* by Pax & Hoffmann range from South Africa to British East Africa, it may not be doubted that *Tragiella* is correctly treated as a synonym of *Sphaerostylis*, with which it agrees both in characters and in range. *Megistostigma*, which Pax & Hoffmann have reduced to *Sphaerostylis*, differs from this genus at least in respect to its range, to its more or less applanate ♂ perianths, to the entire lobes in its ♀ perianth. *Clavistylus*, which Pax & Hoffmann treat as a valid genus, with the note (op. cit., 104): "Genus certissime affine est *Cnesmonae*, sed non stimulosum; insuper differt disco ♂ evoluto, stylis foliisque peltatis," has much less to do with *Cnesmone* than with *Megistostigma*. Smith himself (in Meded. Dep. Landb. 10: 517. 1910) remarks that *Clavistylus* shares with *Megistostigma* the unisexual inflorescence and the characteristic disc of the ♂ flower, together with the thick columnar style. The difference between these two genera, Smith concludes, is that *Clavistylus* has peltate leaves, appendaged anthers, a 3-partite ♀ calyx and a style connate more extensively toward the apex. None of these differences has generic significance, and the new species described in the present contribution, based upon the Wang collections from Yunnan, is intermediate in its characters between the type-species of both *Megistostigma* and *Clavistylus*. It might be suspected that Pax & Hoffmann have not fully grasped the distribution and the morphology of these genera. They assume that *Cnesmone* has no disc, which is not the case. They bring together two monotypic genera based upon species endemic, re-

spectively, in Madagascar and in Malaysia which is certainly unnecessary. In addition, they publish a new genus for three African species which are manifestly allied with the holotype of *Sphaerostylis*, and accept the validity of a Malaysian monotypic genus, *Clavistylus*, which cannot be extricated from *Megistostigma*. I incline to retain two genera which are undoubtedly allied, but are distinct by their ranges and details of morphology. These genera are: *Sphaerostylis* (Syn. nov.: *Tragiella*), which belongs to Eastern Africa, and *Megistostigma* (Syn. nov.: *Clavistylus*), which is endemic in Malaysia and S. W. China.

No material is available here of the three species of *Tragia* described for the flora of the Philippine Islands, *T. irritans* Merr., *T. luzoniensis* Merr. and *T. philippinensis* Merr., and it is impossible to place them on the basis of the descriptions. Pax & Hoffmann (op. cit., 108) treat *T. irritans* as *Pachystylidium hirsutum* (Bl.) Pax & Hoffm. var. β *irritans* (Merr.) Pax & Hoffm., and describe the anthers of the binomial as: "Sessiles, subhorizontales, dorsifixae, extrorsae," adding that the styles are: "In columnam crassam, late conicam connati." The peculiar position of the anthers would seem to be due to their being more or less versatile upon a very short filament, which accounts for their being seen at the same time as sessile, subhorizontal and extrorse. All these plants may as yet be found to fall within the generic limits of *Cnesmone*.

The holotypes must be seen to dispose of *Cnesmone subpeltata* Ridl., *Tragia laevis* Ridl. and *Cnesmone glabrata* Kurz. The ♀ flower of *C. subpeltata* is unknown (see Ridley in Kew Bull., 368. 1923, and Fl. Malay Penins. 3: 307. 1924), but the note: "Anther-cells separated by a wide connective keeled on both sides and prolonged to a short point" fits the stamens of *Megistostigma malaccense* in so precise a manner as to suggest that Ridley's binomial is a synonym of that species. The leaves of *M. malaccense* are not essentially peltate or even subpeltate, but their venation is pinnately triplinerved, and this venation frequently yields subpeltate foliage in the Euphorbiaceae. *Tragia laevis* is said by Ridley (in Kew Bull., 368. 1923 and Fl. Malay Penins. 3: 308. 1924) to have: "disc large circular papillose. Stamens 3, filaments short thick, as long as disc; anther cells 2 separated on a broad thick connective . . . style stout short with 3 fleshy arms with thick papillae on the upper face." These are certainly not the characters of a species of *Tragia* but I may not say whether *Cnesmone* or *Megistostigma* is involved. The key of Pax & Hoffmann (op. cit., 10) would point to the latter (as *Clavistylus*), which is supposedly distinct from *Cnesmone* on account of its having: "Discus ♂ evolutus." Unfortunately, the ♂ flower of certain species of *Cnesmone* has as large and as well formed an annulus as that of *Megistostigma*.

Pax & Hoffmann refer to *Cnesmone glabrata* Kurz as follows (op. cit., 103 *Nota* 2): "A nobis non visa et ab auctoribus omitta, verosimiliter a *C. javanica* vix diversa est." Ridley reduces it to *Megistostigma malaccense* (Ridley's *Sphaerostylis malaccensis*) on the strength of the description, but fails to effect the combination under *Sphaerostylis*, which is required by Art. 54 of the Rules of Nomenclature. Such a combination, *Sphaerostylis glabrata* (Kurz) Merr., is effected in the Papers Mich. Acad. Sc. Bot. **24**: 78. 1938, with *M. malaccense* in synonymy. Kurz's own description does not seem to bear out these dispositions. Kurz (in Flora **58**: 32. 1875) says: "Calycis laciniae lineariblongae, acuminatae, sparse puberulae, fimbriatae, 2 lin. circiter longae, subinde in dentem unum alterumve productae." Despite the added note: "Ovarium . . . stigmatibus glaberrimo magno campanulato-cuneato terminato," this description excludes *Megistostigma malaccense*, which (see Hook. Icon. **16**: pl. 1592. 1887) has entire calyx-lobes. *Cnesmone glabrata* is a *nomen dubium* on the face of the publication, which is to be rejected under the Rules (see Art. 63 and Rec. XXXVII) until such time as the holotype becomes available for certification.

The single species of *Plukenetia* endemic in eastern tropical Asia, *P. corniculata* Sm., is placed by Pax & Hoffmann (op. cit., 22) under *Pterococcus* Hassk., together with two other African endemics, *P. africanus* (Sond.) Pax & Hoffm. and *P. procumbens* (Prain) Pax & Hoffm. Still another genus, *Angostylidium* (Muell. Arg.) Pax & Hoffm., is used by the two authors (op. cit., 17) for *Plukenetia conophora* Muell. Arg., which ranges in tropical western Africa. It may be suspected that this arrangement is not free from the same misconceptions that have suggested the publication of *Tragiella* and the reduction of *Megistostigma* under *Sphaerostylis*. I cannot find characters to separate *Pterococcus* from *Plukenetia*, and agree more than readily with Pax & Hoffmann that *Angostylidium*: "A *Plukenetia* paulo distat." The winged ovary which Pax & Hoffmann (op. cit. 9-10) emphasize in their key to separate *Pterococcus* from *Plukenetia* occurs not only in both genera, but *Plukenetia volubilis* L., which is the *species lectotypica proposita* of the Linnean genus, has a capsule that has winged cocci like *Pterococcus*.

In conclusion, and so far as I know at the present, the PLUKENETIINAE of eastern tropical Asia are distributed as follows:

(1) — *Tragia* L. — The easternmost representative of the genus is said to be *T. novae-hollandiae* Muell. Arg., endemic in Australia, which I have not seen. *Tragia Delphyana* Gagnep. is represented in our herbarium by collections made in Laos and in the Valley of the Mekong,

in French Indo-China. In India proper several species are known, one of which, *T. involucrata* L., appears to be the parent-form of several lesser segregates. In the anthers of *T. involucrata* the connective tends to be thicker than is usual in the genus, and the dehiscence may be introrse. However, *T. bicolor* Miq., which is near *T. involucrata* and like it is endemic in India, has thin filaments and small anthers that dehisce laterally and have no appendages. It seems well established that the Indian species are closely related to those of Africa. *Tragia*, consequently, enters the flora of tropical Asia to a small extent, as an overflow, as it were, of the large African complex under the genus.

(2) — *Cnesmone* Bl. (*Cenesmon* Gagnep., Syn. Nov.; *Tragia* auct. Non L.) — The great majority of the Euphorbiaceae of the Tribe PLUKENETIINAE endemic in tropical Asia and Malaysia belong to this genus. Technically, the anthers' structure, involving the presence of an appendage between the cells, is the generic character. The range extends from Yunnan, in S. W. China, to Malaysia.

(3) — *Megistostigma* Hook f. (*Clavistylus* J. J. Sm., Syn. nov.; *Sphaerostylis* auct. Non Baill.; ? *Tragia* auct. Non L.; ? *Cnesmone* auct. Non Bl.) — Close to *Sphaerostylis* Baill. (*Tragiella* Pax & Hoffm., Syn. nov.), which differs in range (Madagascar, east tropical Africa) and in structural details of the perianth, lobes and anthers. Reported, so far, in S. W. China (*M. yunnanense* Croiz. sp. nov.), in Malaya proper (*M. malaccense* Hook f.) and in the Sunda (*M. peltatum* (J. J. Sm.) Croiz. comb. nov.).

(4) — *Plukenetia* L. (*Pterococcus* Hassk.) — A nearly pandemic genus of less than 12 species ranging from America to eastern Asia through tropical Africa. Represented in Asia by one widespread species, *P. corniculata* Sm., with distribution N. E. India to eastern Malaysia.

These four genera can be keyed as follows:

Anthers numerous, fruit more or less winged. *Plukenetia* L.

Anthers (2-)3, fruit not winged.

Filaments not forming an appendage beyond the anthers, usually thin;
styles spreading. *Tragia* L.

Filaments forming an appendage beyond the anthers, thick.

Stamens more or less triangular, apically dehiscent by a slit; styles
thickened, more or less extensively connate or fused.
. *Megistostigma* Hook f.

Stamens ligulate to subclavate, with a manifest connective between
the anther-cells, dehiscent laterally or introrsely; styles free or
weakly connate. *Cnesmone* Bl.

Plukenetia L.

Plukenetia corniculata Sm. in Nov. Act. Upsal. 6: 4. 1799; Muell. Arg. in DC. Prodr. 15[2]: 772. 1866; Hook. f., Fl. Brit. Ind. 5: 464. 1887; J. J. Sm. in Meded. Dept. Landb. 10: 526. 1910; Merr. in Philip. Jour. Sc. 16: 564. 1920, Enum. Philip. Fl. Pl. 2: 447. 1923.

Pterococcus corniculatus (Sm.) Pax & Hoffm. in Pflanzenr. 68 [IV. 147. IX-XI]: 22. 1919; Merr. in Papers Mich. Acad. Sc. 24: 78. 1938.

Pterococcus glaberrimus Hassk. in Flora 25, Beibl. 41, 2: 41. 1842; Ridl., Fl. Malay Penins. 3: 309. 1924.

SPECIMENS SEEN:¹ *Rahmat Si Boeea* 7593 & 7827, east coast of Sumatra, 1935.

As noticed by Mansfeld (Kew Bull. 454. 1935) and by Merrill, *Pterococcus* Hassk. (1842) is a later homonym of *Pterococcus* Pallas (1776). Hasskarl's name is not worthy of being proposed as a *nomen conservandum*. The material seen strongly suggests at first sight a subherbaceous form of *Acalypha* L. The ♂ perianth is 4-partite, small, and has many stamens.

Tragia L.

Tragia Delphyana Gagnep. in Bull. Soc. Bot. France 71: 1027. 1924, in Lecomte, Fl. Gén. Indo-Ch. 5: 393. 1926.

SPECIMENS SEEN: *Thorel* 2205, Laos [isotype]; *Pierre* s.n., Cochinchina [isosyntype]; *Harmand*, delta of the Mekong.

This is the only authentic species of *Tragia* known to me east of India. The two subsessile stamens are very characteristic.

Megistostigma Hook f.

Megistostigma malaccense Hook. f. in Icon. 16: pl. 1592. 1887, Fl. Brit. Ind. 5: 467. 1888.

Sphaerostylis malaccensis Pax & Hoffm. in Pflanzenr. 68 [IV. 147. IX-XI]: 31, fig. 11 E, F-107. 1919; Ridl. Fl. Malay Penins. 3: 308. 1924.

Sphaerostylis glabrata Merr. in Papers Mich. Acad. Sc. Bot., 24: 78. 1938 [*quoad specimina Sumatrana. An: Cnesmone glabrata* Kurz ?].

SPECIMENS SEEN: *Rahmat Si Boeea* 7186, 8780, 9864, east coast of Sumatra, 1935; *Rahmat Si Toroës* 1389, east coast of Sumatra, 1928.

Hooker's type-illustration is good, although the anthers it shows are

¹All the specimens cited belong to the herbarium of the Arnold Arboretum of Harvard University.

apparently immature. The species is very easily confused at first sight with a narrow-leaved form of *Mallotus* or *Macaranga*.

Megistostigma peltatum (J. J. Sm.) Croiz. comb. nov.

Clavistylus peltatus J. J. Sm. in Meded. Dept. Landb. 10: 517. 1910; Koord., Excurs. Fl. Java 2: 498. 1912; van Steen. in Bull. Jard. Bot. Buitenz. iii. 12: 201, fig. 10. 1932; Pax & Hoffm. in Pflanzenr. 68 [IV. 147. IX-XI]: 104. 1919.

I have not seen specimens, but the illustrations and the careful critical notes of van Steenis, together with the descriptions and the remarks of Smith and Pax & Hoffmann, leave no doubt as to the true position of *Clavistylus*. As previously stated, *M. yunnanense* has characters which are intermediates between those of *M. malaccense* and *M. peltatum*.

Megistostigma cordatum Merr. in Philip. Jour. Sc. 16: 563. 1920, Enum. Philip. Fl. Pl. 2: 446. 1923.

I have seen no material of this species. The description points to a peculiar form for the genus, as it speaks of: "Style pubescent, 2 to 3 mm. long; stigma subglobose, obscurely 3-lobed, glabrous, fleshy, about 6 mm. in diameter."

Megistostigma yunnanense Croiz. sp. nov.

Frutex scandens, primo intuitu *Phaseoli* vel *Dolichi* specimen, ni folia obstarent simplicia, habitu optime mentiens. Caulibus teretibus, striatis, pallidis, sublignosis, sub apicem parcius setulosis, stipulis triangulari-lanceolatis ad 1 cm. longis, brunneis, integris, conspicuis ad basem petiolorum insignitis. Foliis cordatis, plus minusve ellipticis vel obovatis, breviter abrupteque caudatis, integerrimis, nervis utrinque 3-4 adscendentibus, pilis adpressis simplicibus hinc inde obsitis, lamina caeterum glabrescente vel glabra, 12-16 cm. longa, 7-14 cm. lata, [laminis interdum minimis 5 cm. longis, 2 cm. latis], petiolo herbaceo, eglanduloso, sat gracili, parcius pubescente, 4-14 cm. longo. Floribus in cymulis 2-sexualibus congregatis [an semper?], ♂ ca. 7 mm. magnis, perianthio fere ad basem in lobos 3 integros, triangulares, eglandulosos partito, lobis ca. 3 mm. magnis; staminibus 3, triangularibus, carnosulis, processo in medio breviter producto, rima apicaliter dehiscentibus, ca. 1 mm. longis, 1.5 mm. latis, in stipite brevissime insidentibus, more generis annulo haud carnosus, nempe perianthio ipso grosse plicato-rugoso, circumdatis, pistillodio nullo [an semper?]. Floribus ♀ in axillis bractearum foliaceo-subpetaloides latiusculis orientibus, perianthio in lobos 5 partito, 6 mm. longos, 2 mm. latos, integerrimos, lanceolato-

ovatos, petaloideos, venosos; ovario depresso-globuloso, albicante hispidulo, ca. 2 mm. magno, stylis in columnam coalitis, apice subimpresso-partitis [sic immaturis tantum ?], grosse clavatis, glaberrimis, 5 mm. longis, 4 mm. latis. Caetera desiderantur.

YUNNAN: Wang 75870, Sheau-meng-yeang, Cheli, alt. 1100 m., "vine on mountain slope, woods," Sept. 1936 [♂ spec. — *Holotypus*]; Wang 74861, Fo-Hai, alt. 1300 m., "in woods," June 1936 [♀ spec.].

The anthers perfectly match those shown by van Steenis in *M. peltatum* (*Clavistylus peltatus*). In every detail of its gross morphology but the simple leaves, the new species simulates vines of the Leguminosae family. The genus is new for the flora of China, and is likely to turn up in Indochina, where so far it has not been recorded.

Cnesmone Bl.

Cnesmone javanica Bl., Bijdr. 12: 630. 1825 [as *Cnesmosa*, sphalm.]; Bl. & Fisch., Fl. Jav. 1: vi *in nota* [Blume emend., *Cnesmone*]; Baill. Et. Gén. Euphorb. 458, *pl.* 4, *fig.* 14–17. 1858; Muell. Arg. in DC. Prodr. 15[2]: 926. 1866; J. J. Sm. in Meded. Dept. Landb. 10: 513. 1910; Pax & Hoffm. in Pflanzenr. 68 [IV. 147. IX–XI]: 102. 1919; Ridl., Fl. Malay Penins. 3: 306. 1924; Gagnep. in Lecomte, Fl. Gén. Indo-Ch. 5: 385. 1926; Merr. in Univ. Calif. Publ. Bot., 15: 161. 1929.

SPECIMENS SEEN: J. D. H. & T. T., Khasia; Pierre, Indochina; For. Res. Inst. Dehra Dun 15094, Burma; Elmer 20663, Borneo; Brinkman 658, Java.

This species is hardly better understood today than it was one century ago. Ridley published *C. subpeltata* which, as previously noticed, cannot be identified from description and may be merely a leaf-form of Blume's species. The material seen from Khasia is very close to *C. tonkinensis*, a specimen of which, *Balansa* 3259 [fragm. in herb. Arnold Arb.], has been determined by Pax & Hoffmann (op. cit., 102) as *C. javanica*. The ♀ perianth is 6-lobed in *C. tonkinensis* and *C. anisosepala* and 3-lobed in *C. javanica*. However, three of the lobes of the perianth of the species first mentioned are much smaller than the others with which they alternate, and it seems altogether likely that the typical 3-lobed perianth of *C. javanica* is derived from the 6-lobed perianth of *C. tonkinensis* and *C. anisosepala* by abortion of the inner floral whorl [= petals]. On the cited Pierre specimen, which I may not dissect, there is one ♀ perianth in which the relic of a lobule would seem to appear between two normally developed lobes.

Cnesmone laotica (Gagnep.) Croiz. comb. nov.

Cenesmon laoticum Gagnep. in Bull. Soc. Bot. France 71: 867. 1924, in Lecomte, Fl. Gén. Indo-Chin. 5: 390. 1926.

SPECIMENS SEEN: *Thorel*; *Harmand* [Godefroy], Indochina.

Gagnepain describes six sepals in the perianth of this species, three of which are much smaller. Better collection may prove that *C. laotica* falls within the specific limits of *C. tonkinensis* or *C. anisosepala*.

Cnesmone linearis (Gagnep.) Croiz. comb. nov.

Cenesmon lineare Gagnep. in Bull. Soc. Bot. France 71: 867. 1924; in Lecomte, Fl. Gén. Indo-Chin. 5: 389. 1926.

SPECIMENS SEEN: *Thorel*, Indochina.

This, too, may prove to be an extreme form of the *C. tonkinensis* - *C. anisosepala* complex, with very narrow leaves.

Cnesmone peltata (Gagnep.) Croiz. comb. nov.

Cenesmon peltatum Gagnep. in Bull. Soc. Bot. France 71: 868. 1924; in Lecomte, Fl. Gén. Indo-Chin. 5: 392. 1926.

SPECIMENS SEEN: *Poilane* 5493 & 8349, Indochina.

Poilane 8349 has a gross morphology that is strongly reminiscent of *Megistostigma*, and this is probably the material that has prompted Gagnepain (in Bull. Soc. Bot. France 71: 866. 1924) to remark that one of the species of *Cenesmon* is close to *Clavistylus*. The holotype of the species, *Poilane* 5493, however, does not suggest *Clavistylus* and agrees with the gross morphology of *Cnesmone*. I may not say whether these differences are merely the result of individual variations, because the material I have at hand is sterile. Gagnepain's description of the flowers points to *Cnesmone*, witness the characterization of the style as having: "Stigmata 3, lanceolata, valde patentia, tenuia, 3 mm. longa, 1.5 mm. lata, supra papillis conicis majusculis marginantibus tecta."

Cnesmone Poilanei (Gagnep.) Croiz. comb. nov.

Cenesmon Poilanei Gagnep. in Bull. Soc. Bot. France 71: 869. 1924; in Lecomte, Fl. Gén. Indo-Chin. 5: 387. 1926.

SPECIMEN SEEN: *Poilane* 2862, Indochina.

The anthers are those of *Cnesmone*. Although near to small-leaved forms of *C. javanica* and *C. tonkinensis*, this species is likely to prove distinct. The *locus classicus* is the Island of Tré, near Nhatrang, Annam, which is rich in peculiar endemics characterized by small, often distinctly sclerophyllous types of foliage.

Cnesmone tonkinensis (Gagnep.) Croiz. comb. nov.

Cenesmon tonkinense Gagnep. in Bull. Soc. Bot. France 71: 869. 1924;
in Lecomte, Fl. Gén. Indo-Chin. 5: 389. 1926.

SPECIMENS SEEN: *Bon* 5810, Indochina; *Balansa* 3259, Indochina;
Pételot 6520 & 6521, Indochina.

It is difficult to distinguish at sight this species from *C. javanica*, which it matches in every detail of its gross morphology. The ♀ perianth has six lobes, three of which are much smaller. In *C. javanica* the ♀ perianth has only three lobes, suggesting a reduction from the perianth of *C. tonkinensis*. It is probable that intermediates between these two species will be found, with three subabortive lobes. Good material is needed which is now not available.

Cnesmone Mairei (Léveillé) Croiz. comb. nov.

Alchornea Mairei Léveillé Catal. Pl. Yun-nan 94. 1916.

SPECIMEN SEEN: *Maire* s.n., Yunnan.

The nomenclature of this species is altogether confusing. Léveillé published it under *Alchornea* in 1916, basing it upon an unnumbered collection of Maire from the "Vallon de You-fong-kéou" in Yunnan. Handel-Mazzetti mistakenly identified Maire's material as a variety of *Tragia involucrata* L. (Symb. Sin. 7: 218. 1931), which is a very different plant. Rehder accepted Handel-Mazzetti's misdetermination at first (in Jour. Arnold Arb. 14: 234. 1933), but later decided it was a distinct species and effected the combination *Tragia Mairei* (Léveillé) Rehd. (in Jour. Arnold Arb. 18: 214. 1937). While this was going on, Gagnepain found the Maire collection still unnamed in the Paris herbarium and based upon it *Cenesmon Mairei* Gagnep. (in Bull. Soc. Bot. France 71: 868. 1924; in Lecomte, Fl. Gén. Indo-Chin. 5: 391. 1926). Thus the same collection was independently used to publish a species under *Alchornea* and under *Cenesmon*, the same specific epithet being chosen by coincidence by Léveillé and by Gagnepain. A good fragment of the holotype of Gagnepain's binomial is in our herbarium. I have dissected its flowers and I am certain that *Cnesmone* and not *Tragia* is involved. The ♂ perianth has the very conspicuous annulus that is mistakenly believed to be characteristic of the flower of *Megistostigma* and not of that of *Cnesmone*.

Cnesmone anisosepala (Merr. & Chun) Croiz. comb. nov.

Tragia anisosepala Merr. & Chun in Sunyatsenia 2: 261. 1935.

Tragia involucrata Merr. [*fide ipsius*] in Lingn. Jour. Sci. 5: 111. 1927.
Non L.

SPECIMEN SEEN: *Lau* 141, Hainan.

The connective between the anther-cells is well-developed and the annulus is manifest. Further critical comparison with *C. tonkinensis* is desirable.

Cnesmone hainanensis (Merr. & Chun) Croiz. comb. nov.

Cnesmon hainanense Merr. & Chun in Sunyatsenia 5: 94. 1940.

SPECIMEN SEEN: *How 73926*, Hainan.

The ♂ flowers are lacking, but the holotype, which is the single collection so far known, suggests *Cnesmone*, and it is quite unlikely that it may prove to belong to *Tragia*. As remarked in the original publication, *C. hainanensis* resembles *Poilane 5493*, holotype of *C. peltata*. The true affinities of this interesting species are still obscure.

Sphaerostylis Baill.

To dispose of the troublesome synonymy created by the reduction of *Megistostigma* to *Sphaerostylis*, and to reestablish the limits in this group of genera, the following new combinations and listings are required:

Sphaerostylis natalensis (Sond.) Croiz. comb. nov.

Tragia natalensis Sond. in Linnaea 23: 107. 1850; Muell. Arg. in DC. Prodr. 15[2]: 942. 1866; Prain in Dyer, Fl. Trop. Afr. 6[1]: 974. 1913.

Tragiella natalensis (Sond.) Pax & Hoffm. in Pflanzenr. 68 [IV. 147. IX-XI]: 105, fig. 24, A-E. 1919.

Sphaerostylis anomala (Prain) Croiz. comb. nov.

Tragia anomala Prain in Kew Bull. 194. 1912; in Dyer, Fl. Trop. Afr. 6[1]: 975. 1913.

Tragiella anomala (Prain) Pax & Hoffm. in Pflanzenr. 68 [IV. 147. IX-XI]: 106, fig. 24, F. 1919.

Sphaerostylis Frieseana (Prain) Croiz. comb. nov.

Tragia Frieseana Prain in Wissensch. Ergeb. Schwed. Rhodesia-Kongo Exped. 125. 1914.

Tragiella Frieseana (Prain) Pax & Hoffm. in Pflanzenr. 68 [IV. 147. IX-XI]: 106. 1919.

Prain has reduced *Sphaerostylis* to *Tragia*, apparently granting to Baillon's genus a subgeneric or sectional rank (in Dyer, Fl. Trop. Afr. 6[1]: 976. 1913) under the cryptic listing: "*Tragia* (*Sphaerostylis*) *Tulasneana*." I cannot follow him, because the concept of generic limits he adopts in this tribe would tend to bring all its genera under *Tragia*.

Ramelia Baill.

Ramelia codonostylis Baill. in Adans. 11: 132. 1874; Benth. in Benth. & Hook. Gen. Plant. 3: 326. 1880; Guillaum. in Lecomte Not. Syst. 2: 376. 1913; in Arch. Bot. Caen 2[3]: 40. 1929; Pax & Hoffm. in Pflanzenr. 68 [IV. 147. IX-XI]: 108. 1919.

I have not seen material of this rare shrub, which is strictly localized in New Caledonia, and, according to Guillaumin, is synonymous with *Cleidion platystygma* Schlecht. (in Bot. Jahrb. 39: 150. 1907). The lobes of the ♀ calyx form two series, as in *Cnesmone*, but the habit is not that of a climber. *Ramelia*, consequently, is not the same genus as *Cnesmone* or *Megistostigma*. Its phylogenetic significance is still unknown, and it may prove to be an ancestral form to both *Sphaerostylis* and *Megistostigma*. It is certainly a very primitive form.

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THE COMPARATIVE MORPHOLOGY OF THE ICACINACEAE

III. IMPERFORATE TRACHEARY ELEMENTS AND XYLEM PARENCHYMA

I. W. BAILEY AND R. A. HOWARD

With three plates

WE HAVE shown in the second paper of this series (3) that there are salient irreversible trends of structural specialization in the vessels of the Icacinaceae which parallel those that occur in other families of the dicotyledons. These lines of phylogenetic modification are more or less closely synchronized and may be utilized in differentiating the Icacinoidae into successive levels of increasing structural modification.

Bailey and Tupper (2) and Kribs (6) have demonstrated by statistical analyses of the dicotyledons as a whole that there are clearly defined trends of evolutionary changes in the imperforate tracheary elements and the wood parenchyma of the secondary xylem. Although these cells tend in general to become more and more extensively modified with increasing specialization of the cambium and vessels, the rates of the various phylogenetic changes are not the same in all cases. Thus, in a specific family, the modification of the imperforate tracheary elements or of the wood parenchyma may run ahead of or lag behind that of the vessels. It is of interest, accordingly, to study the types of imperforate tracheary elements and of xylem parenchyma that occur in the three major categories of the Icacinoidae which were differentiated in the second paper of this series.

IMPERFORATE TRACHEARY ELEMENTS

The length of the vessel members in the secondary xylem of dicotyledons is determined primarily by the length of the fusiform initials in the cambium. The elongation or contraction of the vessel members during tissue differentiation is so slight in most cases as to be statistically negligible, Bailey (1). On the contrary, the diameters and the cross-sectional area of the vessels are determined largely by the lateral expansion of the vessel members during tissue differentiation. The imperforate tracheary elements of the secondary xylem commonly elongate

more or less during tissue differentiation and, therefore, tend to be considerably longer than the vessel members and than the cambial initials from which they are both derived. The tangential diameters of the imperforate tracheary cells are determined largely by the cambial initials. Therefore, conspicuous fluctuations in the cross-sectional area of imperforate tracheary elements are commonly correlated with variations in the size of the fusiform initials of the cambium.

As we have shown in the preceding paper of this series and as is indicated in Table I, there is a progressive shortening of the vessel members and *pari passu* of the fusiform initials of the cambium with increasing structural specialization of the vessels in the Icacinoidae. If the amount of elongation of the imperforate tracheary elements were the same in all cases, the phylogenetic shortening of the vessel members would of necessity be closely paralleled by a concomitant decrease in length of the imperforate elements. It is evident, however, from the measurements listed in Table I that the elongation of these cells varies in different categories of the Icacinoidae.

TABLE I
MEASUREMENTS IN MICRONS

Categories of Icacinoidae	Average length cambial initials vessel members	Average length imperforate tracheary cells	Average Elongation imperforate tracheary cells
I. Trilacunar Icacinaceae: scalariform	1470	2490	1020
II. Trilacunar Icacinaceae: scalariform-porous	1050	2580	1530
III. A. Unilacunar Icacinaceae: porous	590	1600	1010
III. B-D. Iodeae, Sarcostigmataceae, Phytocreneae: porous	470	870	400

In the group II Icacinoidae, the imperforate tracheary elements are on an average slightly longer than those of Group I. This is due to the fact that, although the cambial initials of Group II are conspicuously shorter than those of Group I, the imperforate tracheary elements elongate more extensively during tissue differentiation. In Group IIIA, the

elongation of these elements is comparable to that in Group I, but the cells are much shorter owing to excessive decrease in the length of the cambial initials. In Group IIIB-D, the imperforate tracheary elements are very short due not only to a further decrease in the length of the cambial initials but also to a reduced elongation during tissue differentiation. It is evident, accordingly, that in the Icacinaceae, as in certain other families of dicotyledons, the specialization of the vessels must be of considerable magnitude before a statistically significant shortening of the imperforate tracheary elements becomes evident.

Although the imperforate tracheary elements of the Group II Icacinoidae are as long and have as large a cross-sectional area as the tracheids of Group I, they commonly exhibit a conspicuous reduction in the size of their bordered pits and in the volume of their lumina. In such genera of the Group I Icacinoidae as *Anisomallon*, *Apodytes*, *Calatola*, *Cassinopsis*, *Dendrobangia*, *Emmotum*, *Oecopetalum*, *Pittosporopsis*, *Platea*, *Poraqueiba*, and *Citronella*, the inter-tracheid bordered pits commonly attain maximal diameters of from 4–5 μ in the first-formed secondary xylem and from 6–8 μ in the later-formed wood. These pits have clearly defined borders in surface view and large conspicuous chambers in sectional view, *Figs. 1 & 2*. In the Group II Icacinoidae, bordered pits of comparable dimensions occur in certain species of *Stemonurus* and *Cantleya*, but less commonly, if ever, in *Discophora*, *Gastrolepis*, *Grisollea*, *Gonocaryum*, *Lasianthera*, *Leptaulus*, *Medusanthera*, and *Urandra*. In the latter genera, not only are the borders of the pits more or less reduced in diameter, *Fig. 3*, but also the pit chambers frequently are flattened and thus are difficult to detect in sectional views of the bordered pits.

In the Group I Icacinoidae, the walls of the tracheids fluctuate from relatively thin in *Platea*, *Fig. 1*, to very thick in *Apodytes*, *Emmotum*, *Fig. 2*, *Ottoschulzia* and certain species of *Citronella*. In the Group II Icacinoidae, with the exception of *Gonocaryum* and of certain species of *Leptaulus* and *Stemonurus*, the lumina of the imperforate tracheary elements are much reduced in volume or are occluded by excessive thickening of the secondary walls, *Fig. 3*.

In the Group IIIA, in contrast to the Group I, Icacinoidae, the imperforate tracheary elements of the arborescent and non-scandent frutescent species exhibit not only a marked decrease in length and in cross-sectional area, *Fig. 4*, but also a conspicuous reduction in size of the bordered pits. The latter trend of specialization is, however, less advanced in *Merrilliodendron* than in *Desmostachys* and *Alsodeiopsis* and particularly than in *Mappia* and *Nothapodytes*. In the last two

genera, the bordered pits have been reduced to simple ones and the transition to libriform fibers is complete, *Fig. 4*. On the contrary, in those representatives of the unilacunar Icacinaceae having a scrambling or climbing habit of growth, as in the scandent Iodeae, Sarcostigmateae and Phytocreneae, there are reversals in the specialization of the imperforate tracheary elements which culminate in the formation of curious short tracheids. These tracheary cells are characterized by having relatively conspicuous lumina and numerous large bordered pits. They are most typically developed in the large-vesselled anomalous wood of *Pleurisanthes*, *Lavigeria* and of various representatives of the Iodeae and Phytocreneae. Intermediate or transitional stages of their phylogenetic differentiation occur in *Humirianthera*, *Ikacina*, *Leretia*, *Rhaphiostylis*, *Mappianthus* and *Sarcostigma*, as well as in the denser, smaller-vesselled parts of the stems of certain Iodeae and Phytocreneae.

WOOD PARENCHYMA

The terminology of wood parenchyma distribution has been and still is somewhat confused and unsatisfactory, and ultimately will have to be revised and clarified. Although a comprehensive revision should not be attempted until more adequate data are available, certain recently proposed modifications of the terminology should be discussed at this time.

There are obviously two fundamentally different categories of wood parenchyma distribution. In the first of these, the distribution bears no specific relationship to the vessels, i.e. contacts between parenchyma and vessels are random and indefinite. On the contrary, in the second type, the parenchyma is definitely aggregated about the vessels. Chalk's (4) suggestion that these two major categories be designated respectively as *apotracheal* and *paratracheal* is, therefore, deserving of careful consideration. Chowdhury (5) has advocated the term, *initial*, for use in contrast to *terminal*, and Kribs (6) has proposed two additional terms, *diffuse-aggregate* and *banded paratracheal*. If these suggestions were generally adopted, the following classification of types of parenchyma distribution would result:

Apotracheal	Paratracheal
diffuse	scanty paratracheal
diffuse-aggregate	banded paratracheal
metatracheal	confluent
terminal	aliform
initial	vasicentric

Such a classification, however, is open to criticism from various angles. The term, metatracheal, was originally used by Sanio (7) for types of distribution in which the vessels are linked together by parenchyma. To use this term for designating an apotracheal type of distribution reverses the original meaning and it appears desirable to replace it by *banded apotracheal*. To make diffuse-aggregate of coordinate rank with diffuse and to confine the use of the latter term to woods in which the wood parenchyma strands are completely isolated from one another is both unnecessary and unwise; woods are classified as diffuse porous regardless of whether the individual vessels are isolated or occur in small clusters. Diffuse-aggregate or preferably *diffuse-in-aggregates* should be used in designating one of several possible sub-divisions of diffuse. In the case of tropical woods, there frequently is considerable difficulty in differentiating banded apotracheal from terminal. The introduction of the term, initial, further complicates the difficulty. Terminal has been utilized from a descriptive or topographical point of view for parenchyma situated at or upon the margins of growth layers, regardless of whether it differentiates at the end or the beginning of a growing season. To interject a purely ontogenetic point of view at this time is inadvisable.

Kribs' (6) statistical investigations have demonstrated that the primitive type of parenchyma distribution in dicotyledons is diffuse and that the aggregation of parenchyma in apotracheal bands and in paratracheal patterns involve varying degrees of phylogenetic specialization. It should be emphasized in this connection, however, that the statistical data do not enable one to determine with certainty how the various paratracheal types have arisen from the apotracheal ones. This can be accomplished only by intensive investigations of a wide range of families. Recent unpublished investigations of this character indicate that (1) broad-banded apotracheal types arise from diffuse ones through various transitional narrow-banded apotracheal types, (2) in many families, vasicentric, aliform and confluent types originate from banded types, and (3) through excessive reduction, scanty paratracheal types may arise at various levels of the differentiation of both apotracheal and paratracheal types. Furthermore, these investigations indicate that there are many complex types of parenchyma distribution which are transitional between typical apotracheal and purely paratracheal types. These distributional patterns are so diverse and variable, not only in related genera and species but also within the limits of a single individual, that it seems unwise to develop a fixed and stereotyped terminology for their description.

In view of such facts as these, we propose to use the following simplified basic terminology:

Apotracheal (Chalk)

diffuse
banded
terminal

Paratracheal (Sanio)

scanty
abundant
abaxial
vasicentric

The more complex transitional types of distribution will be referred to as such. For example, banded paratracheal will be regarded as a mixture of banded apotracheal and paratracheal just as diffuse may be associated with paratracheal, terminal with vasicentric, etc. Confluent and aliform will likewise be regarded as transitional or mixed types. Furthermore, the definition of confluent either should be revised or the term should be used in a purely descriptive sense without implication of origin from coalesced aliform.

The distribution of the wood parenchyma in the Group I Icacinioideae is dominantly of the primitive diffuse apotracheal type, *Fig. 5*. The parenchyma is abundant and tends to occur in small linear aggregates of varying sizes, forms and orientations.¹ Where the parenchyma is reduced in amount, as in the small stems of certain herbarium specimens, there is at times a higher ratio of contacts between parenchyma and vessels than can be accounted for upon the basis of a purely random distribution of the parenchymatous elements. This tendency is much exaggerated in the wood of *Emmotum holosericeum* Ducke and certain exceptional species of *Citronella*, where the distribution is obviously transitional to scanty paratracheal and much of the parenchyma tends to be in contact with the abaxial surfaces of the vessels. In *Poraqueiba*, *Fig. 6*, and particularly in *Ottoschulzia*, there frequently are indications of transitions from diffuse (in tangentially linear aggregates) to narrow-banded apotracheal.

The distribution of wood parenchyma in the Group II Icacinioideae is transitional and highly variable. In *Stemonurus*, *Discophora* and *Gonocaryum*, the parenchyma is abundant and tends to be transitional between diffuse (in tangentially linear aggregates) and narrow banded apotracheal.² In *Medusanthera*, the parenchyma is transitional between these types of distribution and more or less irregularly banded types in

¹For additional illustrations of these types of parenchyma distribution, the reader is referred to *Figs. 1-3* of the preceding paper of this series, Bailey & Howard (3).

²See *Fig. 6* of the preceding paper of this series.

which the vessels are partly or completely jacketed by parenchyma, *Fig. 9*. In *Cantleya*³, *Gastrolepis* and *Urandra*⁴, the parenchyma is scanty paratracheal, but exhibits vestiges of its derivation from apotracheal, *Fig. 10*. In the wood of *Leptaulus daphnoides* Benth., the distribution is transitional from diffuse to very scanty paratracheal, and the parenchyma tends to occur in contact with the abaxial surfaces of the vessels, *Fig. 11*. In small stems from herbarium specimens of *L. grandifolius* Engl., *L. Zenkeri* Engl., and *Grisollea Thomassetii* Hemsl., there are conspicuous arcs of aggregated vessels and parenchyma in the first-formed secondary xylem. However, this is not indicative necessarily of a similar distribution in the later-formed wood. Aberrant distributions of vessels and parenchyma are of not infrequent occurrence in young stems, particularly where growth is excentric or where tropistically induced arcs of gelatinous fibers are formed.

The wood parenchyma of the Group III Icacinioideae occurs in varying mixtures of apotracheal and paratracheal types of distribution and the ratios of the two types fluctuate greatly not only in different genera and species but also in different parts of the same plant. *Merrilliodes* is characterized by having very abundant apotracheal parenchyma, *Fig. 7*. It is transitional between diffuse (in tangentially linear aggregates) and narrow-banded apotracheal and occurs in association with paratracheal parenchyma which encloses the vessels, viz., vasicentric. Similar distributions of apotracheal parenchyma occur in certain representatives of *Nothapodytes*, whereas in others, as in *Mappia*, *Fig. 14*, and *Alsodeiopsis*, *Fig. 8*, the distribution is of a more or less irregular banded apotracheal type. In these plants, the associated paratracheal parenchyma fluctuates between scanty and vasicentric. It should be noted in this connection, however, that there are certain species of *Nothapodytes*, e.g. *N. dimorpha* (Craib) Sleumer and *N. pittosporoides* (Oliv.) Sleumer, which are structurally divergent. Twigs from herbarium specimens of these plants are characterized by having fairly conspicuous growth layers and small vessels in relatively large irregular clusters. The vessels have conspicuous spiral thickenings and the parenchyma is much reduced in amount, occurring as fragments of bands and as scattered isolated cells.

In our material of *Desmostachys*, *Fig. 12*, and of those unilacunar Icacinaceae which have a scrambling or climbing habit of growth, viz., *Icacina*, *Humirianthera*, *Lavigeria*, *Leretia*, *Pleurisanthes*, *Fig. 15*, *Rhyticaryum* and *Rhaphiostylis*, *Fig. 13*, there is a more or less con-

³See *Fig. 4* of the preceding paper of this series.

⁴See *Fig. 7* of the preceding paper of this series.

spicuous reduction in the amount of banded apotracheal parenchyma. The associated paratracheal parenchyma tends to persist as the apotracheal is reduced, and thus there are varied transitions between mixed banded apotracheal and paratracheal types of distribution and others having a prevailing paratracheal or vasicentric distribution. Such fluctuations are of common occurrence in different parts of the same plant, and it is difficult to characterize species or genera by specific types of parenchyma distribution. As the banded apotracheal parenchyma is reduced in amount, it tends to be replaced by shorter and shorter arcs of parenchyma, varying ratios of which are closely associated with the vessels. Under the latter circumstances, the paratracheal parenchyma appears to have winglike or aliform extensions, *Figs. 12 & 13*. This is true regardless of whether the vessels are completely jacketed by paratracheal parenchyma or not.

Similar unstable types of parenchyma distribution occur in the less specialized, small-vesselled parts of the stems of certain representatives of the Phytocreneae and the Iodeae, e.g. *Mappianthus*, *Hosiea sinense* (Oliv.) Hemsl. & Wils., *Iodes liberica* Stapf, etc. In the large-vesselled anomalous wood of these plants, as also of *Pleurisanthes* and *Lavigeria*, the parenchyma tends to be more dominantly paratracheal, *Fig. 16*, and occurs in association with much modified vestiges of banded apotracheal. In *Sarcostigma* and at times in certain of the Phytocreneae, the strands of wood parenchyma tend to be replaced by curious septate fusiform parenchymatous elements; true septate fibers do not occur in the secondary xylem of the Icacinoideae.

It should be noted, in connection with our discussion of wood parenchyma, that the length of parenchyma strands and of fusiform parenchymatous elements is determined by the length of the fusiform initials of the cambium. Therefore the reductions in the length of the vessel members and of the cambial initials in the Group II and Group III Icacinoideae are closely paralleled by concomitant reductions in the length of the parenchymatous elements.

SUMMARY AND CONCLUSIONS

The data presented in the preceding pages indicate that there are salient trends of morphological specialization in the imperforate tracheary elements and the wood parenchyma of the Icacinoideae which tend in general to parallel those that occur in the vessels. Although the phylogenetic modifications of these three categories of cells are not perfectly synchronized in all cases, the differentiation of the Icacinoideae into three Groups, upon the basis of differences in vessel structure,

serves to segregate the imperforate tracheary elements and the wood parenchyma into three general levels of increasing morphological specialization.

In our Group I Icacinioideae, as in many other genera of structurally less modified dicotyledons, the primitive types of vessels occur in association with typical large, more or less thick-walled tracheids. In the Group II Icacinioideae, the imperforate tracheary elements do not exhibit a reduction in length owing to their excessive elongation during tissue differentiation, but do show a conspicuous tendency towards reduction in size of their bordered pits and towards a much exaggerated thickening of their secondary walls. In other words, the imperforate tracheary elements of this group exhibit evidences of a transition from tracheids to fiber-tracheids. In the non-scandent representatives of the Group IIIA Icacinioideae, the imperforate tracheary elements show not only a conspicuous reduction in both length and cross-sectional area, but also in the size of their bordered pits which culminates in *Mappia* and *Nothapodytes* in the formation of libriform fibers. In the scrambling and climbing representatives of the Group IIIA Icacinioideae, as in the scandent Iodeae, Sarcostigmateae and Phytocreneae, there is a further reduction in the length of the imperforate tracheary elements and a tendency for enlargement of the bordered pits. These trends of specialization culminate—as in scandent representatives of a number of other families of the dicotyledons—in the formation of curious short tracheids which resemble the vessels in having numerous, large bordered pits.

The distribution of the wood parenchyma in the Group I Icacinioideae is dominantly of the primitive diffuse apotracheal type. However, the most highly specialized representatives of this group—i.e. from the point of view of the vessels—have parenchyma that is either transitional between diffuse and narrow-banded apotracheal, *Poraqueiba* and *Ottoschulzia*, or between diffuse and scanty abaxial paratracheal, *Emmotum*. The parenchyma of the Group II Icacinioideae fluctuates markedly in both abundance and distribution and exhibits several trends of specialization. In *Stemonurus*, *Discophora* and *Gonocaryum*, it is abundant and is transitional between diffuse (in tangentially linear aggregates) and narrow-banded apotracheal. In *Medusanthera*, it is transitional between these types of distribution and more or less irregularly banded types in which the vessels are partly or completely jacketed by parenchyma. In *Cantleya*, *Gastrolepis* and *Urandra*, the parenchyma is scanty paratracheal, but exhibits vestiges of its derivation from apotracheal. In the wood of *Leptaulus daphnoides* Benth., it is transi-

tional between diffuse and very scanty, abaxial paratracheal. Most, if not all, of the Group III Icacinoidae are characterized by having more or less paratracheal parenchyma that occurs in association with varying percentages of apotracheal. In *Merrilliodendron*, *Mappia* and most species of *Nothapodytes*, the apotracheal parenchyma is abundant and is either transitional between diffuse (in tangentially linear aggregates) and narrow-banded apotracheal or is dominantly banded apotracheal. On the contrary, in the scandent or semi-scandent representatives of the unilacunar Icacinoidae, as in the Iodeae and Phytocreneae, the banded apotracheal parenchyma is exceedingly unstable both as regards its abundance and its distributional patterns. In *Sarcostigma* and in certain of the Phytocreneae, there is a tendency to replace the wood parenchyma strands by curious septate, fusiform parenchymatous elements.

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DESCRIPTION OF PLATES

PLATE I.

- FIG. 1. *Platea species*. Y. U. 20201. Transverse section of thin-walled tracheids, showing three bordered pits in sectional view. $\times 1200$.
- FIG. 2. *Emmotum holosericeum* Ducke. Y. U. 33816. Transverse section of thick-walled tracheids, showing bordered pits in sectional view. $\times 1200$.
- FIG. 3. *Discophora panamensis* Standl. Y. U. 12246. Transverse section of fiber-tracheids and parenchyma, showing pits with reduced borders. $\times 1200$.

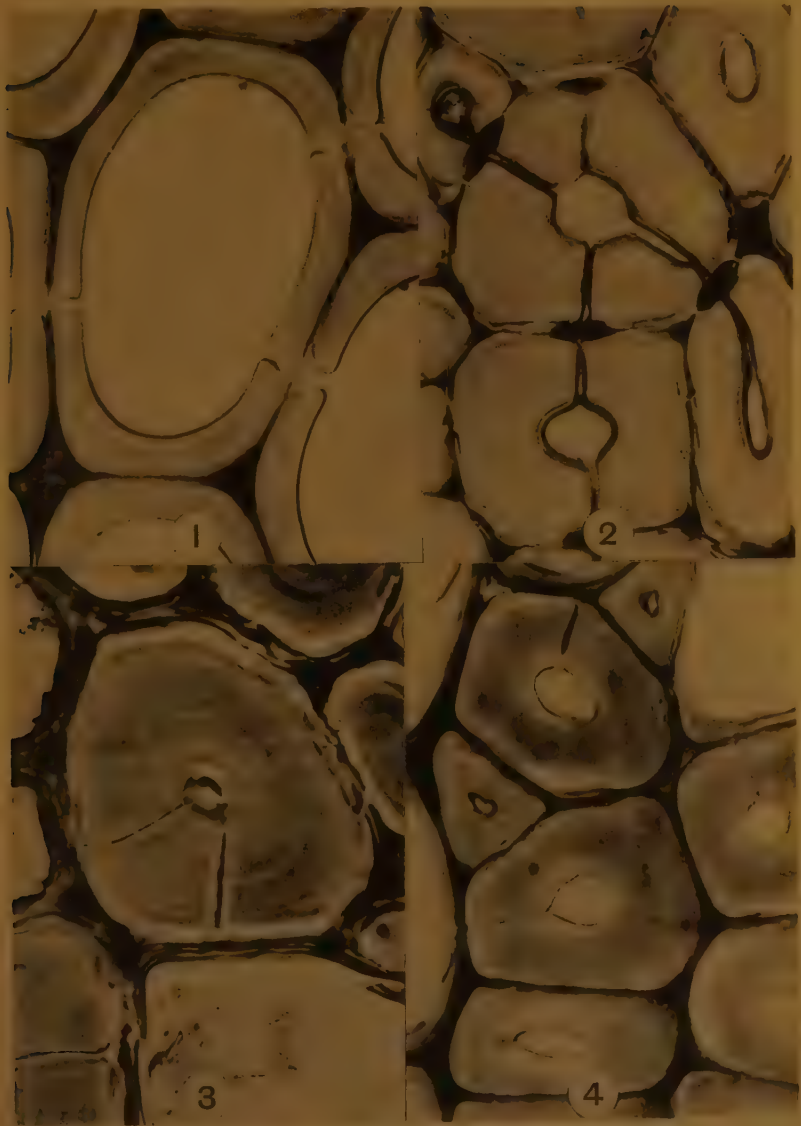
- FIG. 4. *Nothapodytes obtusifolia* (Merr.) Sleumer. *Y. U.* 29539. Transverse section of libriform fibers, showing simple pits. $\times 1200$.

PLATE II.

- FIG. 5. *Apodytes dimidiata* E. Mey. *Y. U.* 14833. Transverse section of the wood. Parenchyma distribution is diffuse-in-aggregates. $\times 50$.
- FIG. 6. *Poraqueiba sericea* Tul. *Y. U.* 19244. Transverse section of the wood. Parenchyma transitional between diffuse (in tangentially linear aggregates) and narrow-banded apotracheal. $\times 50$.
- FIG. 7. *Merrilliodendron rotense* Kanehira. *Y. U.* 19468. Transverse section of the wood. Parenchyma distribution is a mixture of vasicentric and diffuse-in-aggregates. $\times 50$.
- FIG. 8. *Alsodeiopsis Schumanii* Engl. *O. U.* 5060. Transverse section of the wood. Parenchyma distribution is a mixture of banded apotracheal and paratracheal. $\times 50$.
- FIG. 9. *Medusanthera samoensis* (Reinecke) Howard. *Y. U.* 26117. Transverse section of the wood. Parenchyma distribution is a mixture of irregularly banded apotracheal and paratracheal. $\times 50$.
- FIG. 10. *Urandra scorpioides* (Becc.) O. Ktze. *Y. U.* 16043. Transverse section of the wood. Parenchyma is paratracheal and vestigial apotracheal. $\times 50$.

PLATE III.

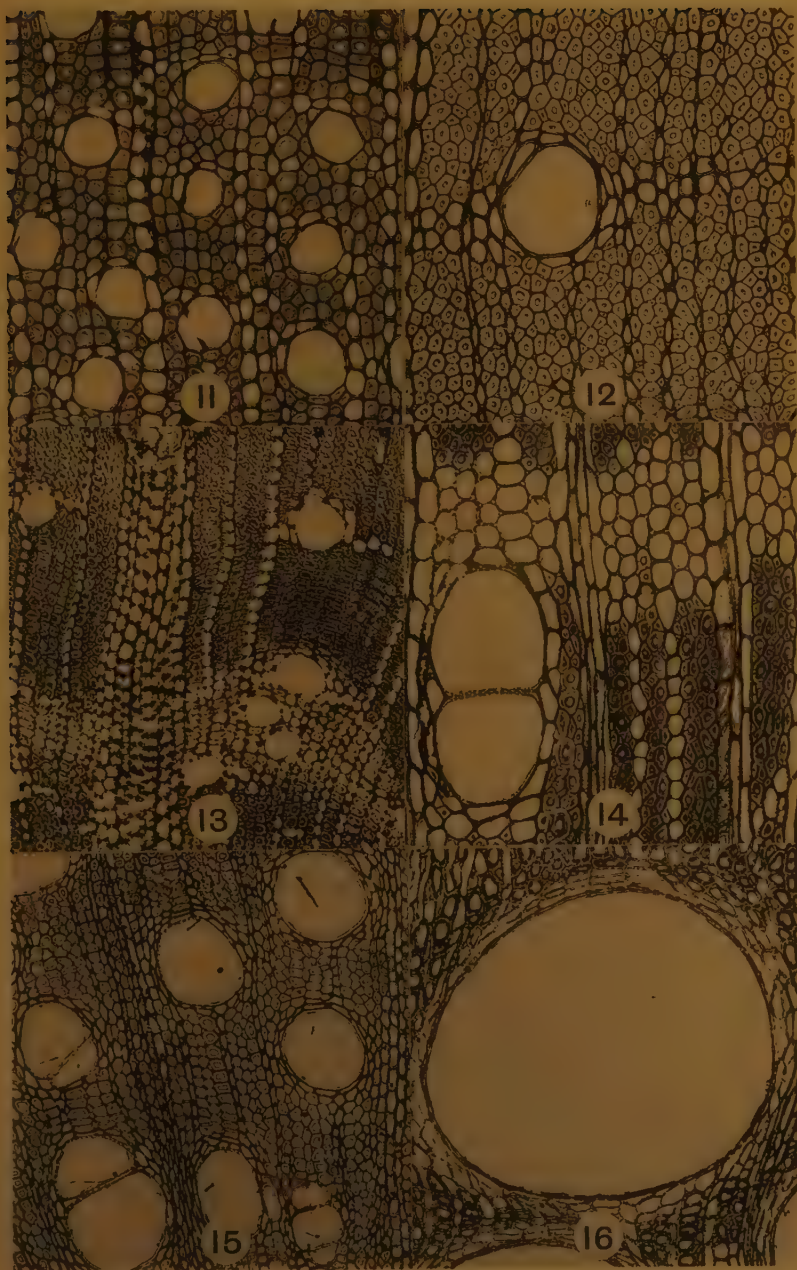
- FIG. 11. *Leptaulus daphnoides* Benth. *Y. U.* 19758. Transverse section of the wood. Parenchyma is scanty diffuse and abaxial paratracheal. $\times 100$.
- FIG. 12. *Desmostachys Vogelii* Stapf. *Y. U.* 15097. Transverse section of the wood. Parenchyma is scanty paratracheal with wing-like or aliform extensions of apotracheal. $\times 100$.
- FIG. 13. *Rhaphiostylis cordifolia* Hutch. *Linder* 1218. Transverse section of a young stem. Parenchyma is scanty paratracheal and vestigial apotracheal. $\times 100$.
- FIG. 14. *Mappia racemosa* Jacq. *Y. U.* 12196. Transverse section of the wood. Parenchyma is scanty paratracheal and broad-banded apotracheal. $\times 100$.
- FIG. 15. *Pleurisanthes flava* Sand. *N. Y.* 590. Transverse section of a young stem. Parenchyma is paratracheal. $\times 100$.
- FIG. 16. *Iodes ovalis* Bl. *H. U.* 2775. Transverse section of large-vesselled anomalous secondary xylem. Parenchyma is vasicentric. $\times 100$.



COMPARATIVE MORPHOLOGY OF THE ICACINACEAE



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SPECIES HYBRIDS IN FOREST TREES

E. CHALMERS SMITH AND CHARLES NICHOLS JR.*

IN ANY breeding project two steps are necessary in the initial production of superior individuals. The first step is the selection of superior parental types for crossing. The choice of breeding stocks is especially important in natural populations not subjected to artificial selection. The second step is the production of hybrids between the superior types to obtain favorable gene combinations resulting in hybrid vigor. The success of such a program in tree breeding is well illustrated in the selection and breeding of *Hevea* for rubber production (Bangham and D'Angremond, 1939). In most tree breeding projects less attention can be given to the initial selection because of the time involved, and favorable results must depend more on the increased vigor of the first generation hybrids. Such a program also involves adequate methods for vegetative propagation of the F_1 hybrids.

In any comprehensive study of forest genetics the question of seed origin or provenance must play an important role. Recent papers discussing current programs for forest tree improvement emphasize this point. It may be well to recall that while forest genetics is a relatively new field of endeavor, provenance studies have been carried on since the first part of the 19th century (Langlet, 1936; Kalela, 1937). As far back as the middle of the 18th century Swedish foresters recognized the existence of distinct races or types in pine and raised the question as to whether these differences were entirely due to environmental conditions or whether some more fundamental differences were present.

Credit for the first experimental approach to the subject of seed origin should go to De Vilmorin (1862). As early as 1823 he studied seed cultures using pine seed from different regions. From these experiments De Vilmorin was able to conclude that from pine seed of different origins one would obtain trees which were quite different in form and rate of growth. Throughout the 19th century provenance studies were carried out in Europe and particularly in Sweden where experience had taught foresters that seed of German origin produced inferior stands when planted in the more rigorous climate of Sweden.

The general conclusion to be drawn from the vast number of experi-

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ments on provenance is that seed of local origin is the best type to be planted in a given region. However, as Schreiner (1937) has pointed out, there are exceptions to this general rule and for this reason more complete data on seed origin will be of invaluable aid in any program of forest genetics. It is well known that among trees of a given area there may be differences in rate of growth, form, and resistance to disease or adverse environmental conditions. For this reason it is desirable from the point of view of forest genetics to make progeny tests from individual trees in order that the very best trees may be selected for hybridizing experiments.

Simultaneously with investigations of seed origin and progeny tests actual hybridizing among forest tree genera, species, and varieties must play an important part in any program of forest tree improvement. It is only in comparatively recent years that this phase of the problem has been undertaken on a large scale. However, for over a century foresters have considered the production of entirely new types of forest trees by means of hybridization. Klotzsch (1854) was apparently the first investigator to report hybridizing experiments in forest trees. In 1845 he produced artificial hybrids in pine, oak, elm, and alder and noted remarkable vigor in the hybrids. In 1891 Luther Burbank is reported to have produced the remarkable Paradox walnut, a hybrid between *Juglans regia* and *J. californica*. It was not until the early part of the 20th century that Augustine Henry gave new impetus to the idea of breeding forest trees. In 1914 Henry reported on artificial hybridization in ash, elm, larch, poplar, beech, and oak.

Since 1914 many programs of forest tree breeding have been initiated in this country as well as in Europe. Worthy of mention among these more recent attempts are the chestnut breeding experiments endeavoring to obtain a blight resistant type, the poplar hybridization work of the Oxford Paper Company, and the work of the Institute of Forest Genetics in California which was undertaken in 1925.

In planning a program of forest tree improvement it is well to consider carefully just what improvements will be of most value. Increased vigor and rate of growth are commonly found in first generation species hybrids. This fact immediately suggests that rapidity of growth would be one of the primary aims in producing forest tree hybrids. However, there are other facts which must be taken into consideration. If a particular forest tree is used exclusively for timber production then the quality of the timber in the hybrid is of utmost importance. Generally speaking, timber from the more rapid growing conifers is somewhat weaker and inferior to the timber from slower growing trees. On the

other hand, in certain of the best hardwood timber trees, rapidity of growth tends to strengthen and improve the quality of the timber (Henry, 1914). Certain forest trees such as spruce and poplar are used largely for pulp and plastics. In such cases the strength and quality of the wood is of secondary importance. The primary aim would be the production of a rapid growing hybrid from which a merchantable crop could be obtained in a shorter period of time.

Perhaps of equal importance in hybrid forest trees is the question of disease resistance. Plant breeders dealing with agricultural crops have always found disease resistance of primary importance. In order to realize that disease resistance is important in forestry it is only necessary to recall the fate of the American chestnut. Foresters are aware of this fact and intensive breeding experiments have been in progress in an attempt to produce a chestnut which is resistant to the chestnut blight and still retains all the desirable qualities of a good timber tree.

The importance of seed origin studies and hybridization have been discussed briefly above. There is another phase of the problem which must not be neglected. Seed from first generation hybrids does not breed true. Therefore, in order to perpetuate any desirable hybrid, vegetative reproduction must be used. If vegetative reproduction can be used successfully the hybrids may be multiplied rapidly without waiting for the trees to mature and there is no danger of losing any of the first generation vigor or other advantageous characters.

Vegetative propagation of most conifers and many of the commonest hardwood trees has been considered difficult (Thimann and Delisle, 1939). Extensive studies on rooting ability reveal the fact that with the aid of optimal concentrations of auxin and proper age of the trees from which cuttings are taken, most of the difficult species can be rooted. Cuttings from young white pine trees, 3 or 4 years old, root most successfully. However, not many cuttings can be obtained from a single tree of such an age and vegetative propagation is not yet possible on a commercially profitable scale.

The recent discovery that colchicine may be used to double the chromosome number in plants makes this chemical a valuable aid to plant breeders. In cases where a species hybrid is sterile, the use of colchicine may double the chromosome number to produce a true breeding amphidiploid with complete fertility. Colchicine may be of further value in forestry by producing polyploid forms of existing forest tree types. The polyploid forms are often more vigorous than the diploid forms from which they were derived.

A study of natural hybridization is of value in showing the degree of

species hybridization in various genera. The occurrence of natural interspecific hybrids in forest trees depends upon the realization of three conditions—that flowering times of the species coincide, that the genetic relationships between the species concerned be such as to permit crossing, and that the geographic distribution of the species coincide to some extent. These conditions are sufficient to account for natural hybrids in the case of dioecious species, however, isolation mechanisms such as self-sterility, protandry, and protogyny are required in the case of monoecious species. Protandry and protogyny are widespread in forest tree genera (Larsen, 1937; East, 1940). In regard to self-sterility Larsen has this to say, "The majority of our forest trees should not be classified for purposes of breeding with the absolutely self-sterile plants but ought rather to be included among those plants which normally are cross-pollinated but can by artificial means be rendered self-pollinated."

Due to the widespread occurrence of protandry and protogyny and the occasional occurrence of dioecious species in forest trees, natural interspecific hybrids are common. Among these the London plane, *Platanus acerifolia* (Ait.) Willd., the cricket-bat willow, *Salix alba* L. var. *calva* G. F. W. Mey., and the common linden, *Tilia europaea* L., are natural hybrids of considerable economic importance. *Platanus acerifolia*, according to Henry and Flood (1919), originated in the Oxford Botanic Garden about 1670 as the result of a cross between *P. occidentalis* L. and *P. orientalis* L. This tree is extensively planted as a shade tree in localities where neither parent can survive. *Tilia europaea* is widely planted and is valuable as a hardy shade tree. It is the hybrid *T. cordata* Mill. \times *T. platyphyllos* Scop. *Salix alba* var. *calva* is recognized by Henry (1914) as a hybrid between *S. alba* and *S. fragilis* L. It probably originated at Norfolk, England, about 1700 and is used extensively in the manufacture of cricket-bats. However, Wilkinson (1941), on the basis of a cytological investigation of *S. alba*, *S. fragilis*, their varieties and hybrids concludes that *S. alba* var. *coerulea* (= *S. alba* var. *calva*) is a variety of *S. alba* and not a hybrid.

The occurrence of natural hybrids in the genera of forest trees and the success of artificial species hybrids provides some information of value in planning a breeding program, and at the same time indicates the relationships of the species in the various genera. The chromosome numbers also are of interest in respect to crossing diploid and polyploid species, and provide some indication of the probable success of the artificial production of polyploids.

The data on natural and artificial interspecific hybrids in sixteen genera of local importance are shown in table 1. Of these genera only

one, *Fagus* L., has no interspecific hybrids reported. The table is based for the most part on the list of interspecific hybrids in tree genera published by Johnson (1939). Some additions and changes have been made. Crosses using varieties of species or hybrids which have not been assigned a specific name as parents have been omitted. It is unfortunate that in the original hybrid lists, the name of the authority for the species name was often omitted. Nevertheless, an attempt has been made to bring these lists into agreement with the system of naming used by Rehder (1940). The same authority was used for approximate number of species within the genera and for division of the genera into subgenera, sections and series. Chromosome numbers were taken from the lists of Tischler (1927, 1931, 1936, 1938) and from various later publications (Peto, 1938; Dillewijn, 1940; Duffield, 1940). In the case of *Populus* and *Catalpa* some chromosome numbers were taken from the work of Smith (unpublished).

TABLE I

GENUS	SPECIES IN GENUS	CHROMOSOME NUMBER	NATURAL HYBRIDS	ARTIFICIAL HYBRIDS	SPECIES USED IN CROSSES
ABIES	40	12	2	1	5
ACER	115	13, 26, 39, 52 2	10	1	11
BETULA	40	14, 28, 35, 42	11	11	14
CARYA	20	16, 32	7	0	7
CASTANEA	10	12	6	10	8
CATALPA	10	20	1	1	2
FAGUS	10	12	0	0	0
FRAXINUS	65	23, 69	0	4	4
JUGLANS	15	16	7	8	6
LARIX	10	12	6	4	9
PICEA	40	12	4	3	6
PINUS	80	12	11	7	20
POPULUS	30	19, 57 2	12	81	27
QUERCUS	200	12	60	2	50
TILIA	30	41, 82	9	0	9
ULMUS	18	14, 28	3	3	7

The genus *Acer* L. is divided into fourteen sections. The hybrids listed are the result of crosses between species within the section *Platanoides* Pax and the section *Spicata* Pax, and crosses between species belonging to different sections as follows: *Platanoides* \times *Campestris* Pax, *Campestris* \times *Spicata*, *Spicata* \times *Macrantha* Pax. Most of the crosses occur between the sections *Campestris* and *Spicata* with only one cross between the sections *Spicata* and *Macrantha*. Chromosome counts up to this time, based on the examination of some seventeen species, show a polyploid series based on a reduced number of $n = 13$. Meurman (1933) finds that, on the basis of secondary association of chromosomes in *A. platanoides* L., the basic ancestral chromosome number is $n = 12$. The genus is self-fertile as far as is known (East, 1940). The artificial cross *A. rubrum* L. \times *A. saccharinum* L. has been reported by Freeman (1941). Both parent species belong to the section *Rubra* Pax.

The genus *Fraxinus* L. is divided into sections and subsections. Johnson (1939) does not list any hybrids in this genus, but Henry (1914) reports seedlings from four crosses. Some of these were seen by Anderson in 1934 (Anderson and Whelden, 1936), at which time they were vigorous young trees. All four crosses occur between species within the same section of the genus, *Fraxinaster* DC. Two are crosses within the subsection *Melioides* Endl., and two are crosses between the subsections *Melioides* and *Bumelioides* Engl. The work of Anderson and Turrill (1938) indicates that natural hybridization does take place in the case of *F. oxycarpa* Willd. and *F. pallisae* Wilmott. Of the six species for which chromosome numbers have been determined, five have the reduced number $n = 23$ while one species has $n = 69$. East (1940) reports no cases of self-sterility in this genus.

Quercus L. is divided into three subgenera, the last of which is redivided into six sections. Hybridization in this genus seems to be limited to species which belong to the same subgenus (Trelease, 1924; Johnson, 1939). In the case of the subgenus *Lepidobalanus* Endl., crossing occurs between species belonging to different sections, although most of this is limited to the section *Prinus* Loud. On the basis of chromosome counts of forty-six species, the genus has a chromosome number of $n = 12$.

The Fagales and especially the genera *Betula* L., *Fagus* L., *Castanea* Mill., and *Quercus* are very protandrous, so much so that isolated trees bear almost no fruit, but there seems to be no difficulty in getting selfed seed by artificial pollination. All are self-fertile (East, 1940). The chromosome number in *Fagus* is 12, in *Castanea* 12, in *Betula* the base

number is 14 but a polyploid series of 14, 28, 35, and 42 exists. These reduced numbers are founded on chromosome counts of one, two, and twenty-five species and varieties respectively.

The genus *Populus* L. is divided into five sections, *Leuce* Duby, *Leucoides* Spach, *Tacamahaca* Spach, *Aegeiros* Duby, and *Turanga* Bge. Species hybrids within and between the sections *Leuce*, *Tacamahaca* and *Aegeiros* are known, although those within and between the latter two sections are the most common. Johnson (1939) states that there appears to be little limitation to species hybridization in this genus. Heimbürger (1940) sees a definite limitation to species hybridization based on genetic affinities which cause crossing to follow a series similar to the series aspens—silver poplars—cottonwoods—balsam poplars. Thus far no crosses involving species belonging to the sections *Leucoides* and *Turanga* have been reported, but it seems to be possible to make any desired cross between and within the remaining three sections. Chromosome counts based on the investigation of thirty-six species and varieties of *Populus* show the reduced number in this genus to be 19. Occasional triploid forms are known within the section *Leuce*. One tetraploid form has been reported, but subsequent investigations show that $n = 19$ is the common haploid number for this species, although it is conceivable that it does exist in the tetraploid form. Dillewijn (1940), on the basis of secondary association of chromosomes at pre-meiotic metaphase of the meiotic divisions, concludes that $n = 8$ is the real base number and that the genus is a secondary polyploid. The genus is dioecious as a rule. When monoecious trees appear they are self-fertile (East, 1940).

Ulmus L. is divided into five sections. The reported hybrids occur between species in the section *Madocarpus* Dum. There is one exception, the probable hybrid which Klotzsch produced in 1845 and reported as *U. campestre* \times *U. effusa*. The parent species, if correctly given, here belong to the sections *Madocarpus* and *Blepharocarpus* Dum. respectively. Chromosome counts of thirteen species show the reduced number to be 14, with one tetraploid species. As far as is known all species within this genus are self-fertile but there is marked protogyny (East, 1940).

The genus *Carya* Nutt. has a haploid number of $n = 16$, with some tetraploid species. These conclusions are based on an investigation of seven species. *Juglans* L. also has a reduced number of 16 based on counts of seven species. East (1940) has investigated all the common species of *Juglans* and *Carya* and finds them to be self-fertile, though tending to be protandrous.

Tilia L. has one or more species known to be self-fertile, while a considerable amount of protandry is known in the Tiliaceae. In *Tilia*, chromosome counts on 12 species show the basic haploid number to be $n = 41$, with both diploids and tetraploids known in the genus. *Catalpa* Scop., of the Bignoniaceae, is a self-fertile genus (East, 1940). The haploid chromosome number in the genus is 20 based on the examination of three species.

The genus *Picea* A. Dietr. is divided into three sections. The hybrids listed occur as the result of crosses both between and within sections, with more occurring between than within the sections.

Pinus L. is divided into two subgenera, three sections, and ten series. With few exceptions hybrids occur between species belonging to the same series. There are no reported hybrids from crosses of species belonging to different sections or subgenera. The parents of most of the reported hybrids belong to the subgenus *Diploxylon* Koehne, section *Pinaster* Endl. Two hybrids are reported between species belonging to the subgenus *Haploxylon* Koehne, section *Cembra* Spach.

In the genera of the Pinaceae considered here all the species thus far investigated have the reduced chromosome number of $n = 12$. This number is based on the examination of five, six, five, and twenty-one species respectively for the genera *Abies* Mill., *Larix* Mill., *Picea*, and *Pinus*. They are thought to be self-fertile though normally cross-pollinated (Larsen, 1937).

The hybridization work at the Arnold Arboretum has been limited largely to *Populus*, *Betula* and *Pinus*. These genera are of value in reforestation projects particularly where the trees are to be used as a source of cellulose. The incidence of both natural and artificial hybrids shows that interspecific hybridization in these genera occurs readily.

The technique employed in the hybridization of forest trees is essentially that employed in the breeding of any flowering plants. Schreiner (1938), among others, has published on methods of tree hybridization. However, each genus requires modifications of the general technique.

Yanchevsky (1904) seems to have been the first to use a method by which flowering branches of *Salix* were brought into the greenhouse, flowered, and seed matured. Wettstein (1933) employed this method in *Populus*. The authors have also used this method in this genus, where it has proved most successful in the case of species belonging to the section *Leuce*. Crosses in other sections of the genus were more successful when made on the trees. Since pollen from all species of *Populus* may be forced in the greenhouse, the advantage of being able to overcome natural differences in blooming time is not lost when crossing must be done in the field.

The forcing of pollen in the greenhouse may be used successfully in the case of *Betula*. Here sausage tubing may be used in place of the usual glassine bags when it is desired to cover a large number of small flowers on one branch. The best results were obtained when the ends of the tube were plugged with cotton wool, thus allowing for some aëration.

Ulmus may be treated in a manner similar to *Populus* in that branches may be brought into the greenhouse and flowered, crosses made, and seed matured. The perfect flowers of *Ulmus* are small and difficult to emasculate. However, since the genus is strongly protogynous, crosses may be made without emasculation. This method was used successfully by the authors in certain crosses made in the greenhouses of the Arnold Arboretum in the spring of 1938. As the knowledge of flowering habits in forest trees grows, increasing use of protandry, protogyny, and self-sterility will simplify hybridization techniques.

Isolated trees of dioecious species or of monoecious species which are strongly protandrous or protogynous may be used as a source of hybrid seed providing that trees of other species in the genus are flowering in the neighborhood. Accurate records on the blooming times of all trees in the vicinity will aid in determining what the male parents probably are.

In the genus *Quercus* there are a large number of natural hybrids but very few reports of artificial hybrids. This must indicate that proper techniques have not yet been developed for this group. A similar lack of technique probably accounts for the failure to obtain artificial hybrids in the genus *Acer*.

There is some evidence that an overabundance of pollen on the stigmas of female flowers in *Juglans* and *Carya* prevents crosses from being successful. Special techniques are needed in order that small amounts of pollen can be used when dealing with these groups.

Very often a cross may yield a good set of seed but the seed may not germinate. In many cases this failure of germination may be due to an upset in the ratio of embryo size to endosperm size. This difficulty may be overcome by making use of the technique of embryo culture. If the embryo is removed from the seed at the critical stage and placed on nutrient media a healthy and mature plant may be obtained where ordinary methods of germination fail.

Crosses between species of *Pinus* and other genera of conifers have been made, but the resulting seedlings are not large enough for critical study. The work on *Pinus* has been confined to the white pine species.

The hybrids in the genus *Populus* are grown in nursery plots and are cut back severely to induce an abundance of lateral sprouts from which

cuttings can be obtained. These cuttings will provide the trees to be tested at the Harvard Forest in comparison with the parental species or with hybrids of known value.

The authors have attempted a number of interspecific crosses in the genera *Abies*, *Betula*, *Carya*, *Catalpa*, *Fagus*, *Fraxinus*, *Juglans*, *Picea*, *Pinus*, *Populus*, *Quercus*, and *Ulmus* during the past three years. This work has been done under the Maria Moors Cabot Foundation for Botanical Research on trees growing in the Arnold Arboretum of Harvard University. The following list of crosses represents part of the work done in the years 1938 and 1939. The resulting trees have been tentatively identified as hybrids. No attempt has as yet been made to compare the vigor of these young trees with that of the parent trees or with other hybrids, but the cross *Ulmus Wilsoniana* Schneid. \times *U. japonica* (Rehd.) Sarg. seems to be more vigorous and more resistant to insect attack than is *U. japonica*. Among the hybrids in the genus *Populus*, those crosses using the species *P. Maximowiczii* Henry as the female parent seem to be the most promising.

Betula L.

B. mandshurica (Reg.) Nakai var. *japonica* (Miq.) Rehd. \times *B. lenta* L.
B. mandshurica (Reg.) Nakai var. *japonica* (Miq.) Rehd. \times *B. Maximowicziana* Reg.

B. mandshurica (Reg.) Nakai var. *japonica* (Miq.) Rehd. \times *B. nigra* L.
B. mandshurica (Reg.) Nakai var. *japonica* (Miq.) Rehd. \times *B. populifolia* Marsh.

B. mandshurica (Reg.) Nakai var. *japonica* (Miq.) Rehd. \times *B. papyrifera* Marsh.

B. lutea Michx. \times *B. lenta* L.

B. papyrifera Marsh. var. *kenica* (Evans) Henry \times *B. mandshurica* (Reg.) Nakai var. *japonica* (Miq.) Rehd.

B. populifolia Marsh. \times *B. lenta* L.

B. populifolia Marsh. \times *B. papyrifera* Marsh.

Populus L.

P. alba L. var. *nivea* Ait. \times *P. deltoides* Marsh.

P. alba L. var. *nivea* Ait. \times *P. adenopoda* Maxim.

P. canescens (Ait.) Sm. \times *P. alba* L. diploid

P. canescens (Ait.) Sm. \times *P. alba* L. triploid

P. canescens (Ait.) Sm. \times *P. deltoides* Marsh.

P. canescens (Ait.) Sm. \times *P. tomentosa* Carr.

P. cathayana Rehd. \times *P. deltoides* Marsh.

P. cathayana Rehd. \times *P. laurifolia* Ledeb.

P. deltoides Marsh. \times *P. acuminata* Rydb.

P. deltoides Marsh. \times *P. canadensis* Moench.

P. deltoides Marsh. \times *P. nigra* L.

P. Maximowiczii Henry \times *P. deltoides* Marsh.

- P. Maximowiczii* Henry \times *P. laurifolia* Ledeb.
P. Maximowiczii Henry \times *P. nigra* L.
P. Maximowiczii Henry \times *P. tomentosa* Carr.
P. nigra L. var. *italica* Muenchh. \times \times *P. canadensis* Moench.
P. Sargentii Dode \times *P. acuminata* Rydb.
P. Sargentii Dode \times *P. deltoides* Marsh.
P. Tacamahaca Mill. \times \times *P. canadensis* Moench.
P. Tacamahaca Mill. \times *P. deltoides* Marsh.
P. Tacamahaca Mill. \times *P. nigra* L.
P. Tacamahaca Mill. \times *P. nigra* L. var. *italica* Muenchh.
P. Tacamahaca Mill. \times *P. Simonii* Carr.
P. tomentosa Carr. \times *P. adenopoda* Maxim.
P. tomentosa Carr. \times *P. alba* L. diploid
P. tomentosa Carr. \times *P. alba* L. triploid

Ulmus L.

- \times *U. hollandica* Mill. \times *U. japonica* (Rehd.) Sarg.
U. Wilsoniana Schneid. \times *U. japonica* (Rehd.) Sarg.

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A NOTE ON THE DATES OF ISSUE OF THE FASCICLES
COMPRISING COSSON'S "ILLUSTRATIONES FLORAE
ATLANTICAE" 1882-1897

E. D. MERRILL

As noted by Stearn* in his comprehensive consideration of the dates of publication of this important two-volume work, the inclusive dates for volume one are 1882-1890 and for volume two 1893-1897, publication thus extending over a period of fifteen years. The only reason for the publication of this note is the fact that Stearns saw no fascicle covers, which carry the dates of publication and the inclusive pages and plates of each fascicle. A second set of the work was recently acquired by the Arnold Arboretum, this fortunately in its original fascicle covers. In our bound library set the fascicle covers are missing, and this seems to be the case in most libraries; the chief reason for their non-preservation, other than the earlier and unfortunately common practice of discarding such covers, is probably due to the fact that the covers are of rather heavy bristol board and thus were not adaptable to binding. The following data are taken directly from the original fascicle covers:

VOLUME I

	FASCICLE COVER DATES	STEARNS' DATES
Fasc. I, pp. 1-36, <i>t.</i> 1-25.	Sept., 1882	Oct. 10, 1882
Fasc. II, pp. 37-72, <i>t.</i> 26-50.	Aug., 1884	August, 1884
Fasc. III, pp. 73-120, <i>t.</i> 51-73.	Dec., 1888	Jan.-Feb., 1889
Fasc. IV, pp. 121-159, <i>t.</i> 74-98.	Oct., 1890	Jan. 10, 1891

VOLUME II

Fasc. V, pp. 7-42, <i>t.</i> 99-123.	Feb., 1892	April, 1892
Fasc. VI, pp. 43-82, <i>t.</i> 124-148.	Nov., 1893	Nov.-Dec., 1893
Fasc. VII, pp. 1-6, 83-125, <i>t.</i> 149-175.	May, 1897	July-Aug., 1897

*STEARNS, W. T. Dates of publication of some floras of north-west Africa: Desfontaines' "Flora Atlantica," Cosson's "Compendium," Cosson and Baratte's "Illustrationes," Battander and Trabut's "Flore." Jour. Soc. Bibl. Nat. Hist. 1: 145-150. 1938.

While it is a well known fact that the printed dates on fascicle covers are not always the *exact* dates of issue, they are in general dependable. Here is a case where there is a rather remarkable agreement as to the dates of issue of the several parts as between the data taken directly from a set of the original fascicle covers and those derived from Stearn's critical search of records and reviews. For fascicle two the dates are the same by both methods, August, 1884; fascicles one, three and six are about one month earlier than the dates as derived by Stearn; fascicle five is at most two months earlier; and fascicles four and seven are between two and three months earlier.

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